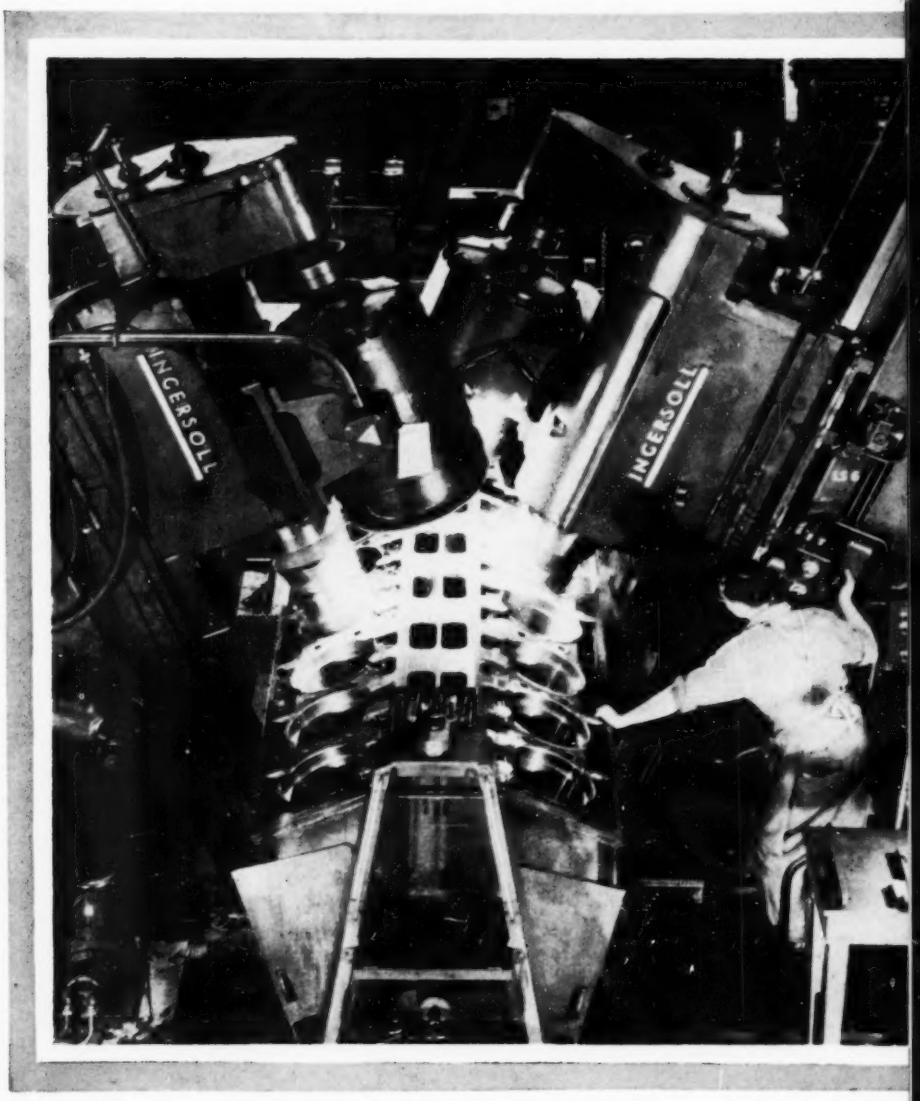
DIESEL POWER

AND DIESEL TRANSPORTATION

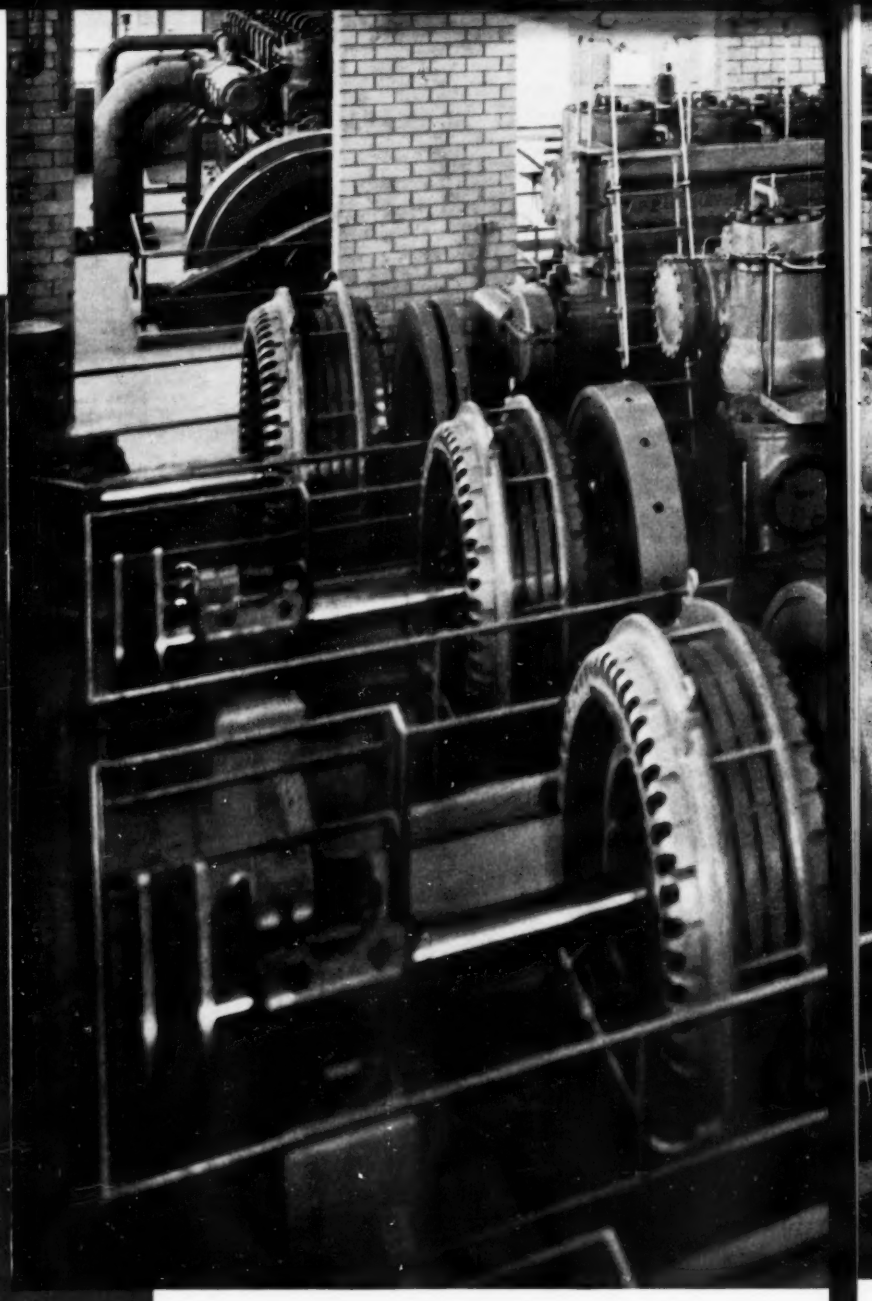
OCTOBER, 1953

- *GM "71" Tune Up*
- *Checking I-H Injection Systems*
- *Visually Analyzing Bearing Troubles*



TOOL AND MAINTENANCE NUMBER

2 COSTS THAT CAN BE CUT...

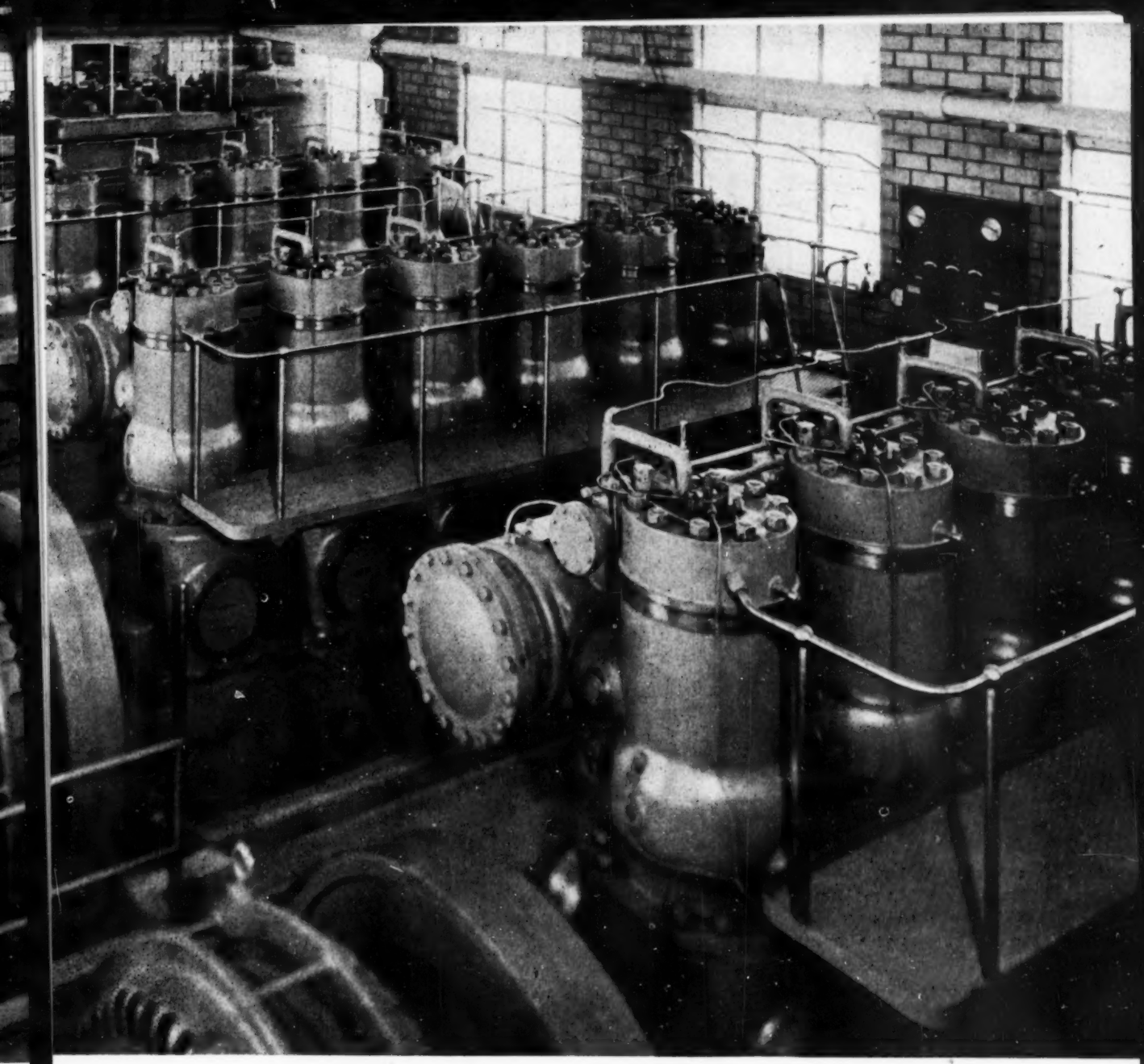


BY USING the lubricating oil that's *exactly right* for your particular Diesels and operating conditions, you can save on 1) the amount of fuel used, and 2) your maintenance costs.

Texaco makes *a complete line* of lubricating oils for Diesel, gas and dual-fuel engines—the *Texaco Ursa Oil* series—especially designed to resist oxidation and assure clean operation. *Texaco Ursa Oils*

TEXACO

TEXACO



keep engines free from carbon and sludge . . . keep rings free for proper compression and combustion . . . assure longer life for bearings and other moving parts.

Because the *Texaco Ursa Oil* series is complete, you can count on a *Texaco Ursa Oil* that is just right to step up the efficiency of your engines and bring down your operating cost regardless of type, size, speed of your Diesels or fuel used. A Texaco Lubrication Engineer will gladly help you make the proper selection.

Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

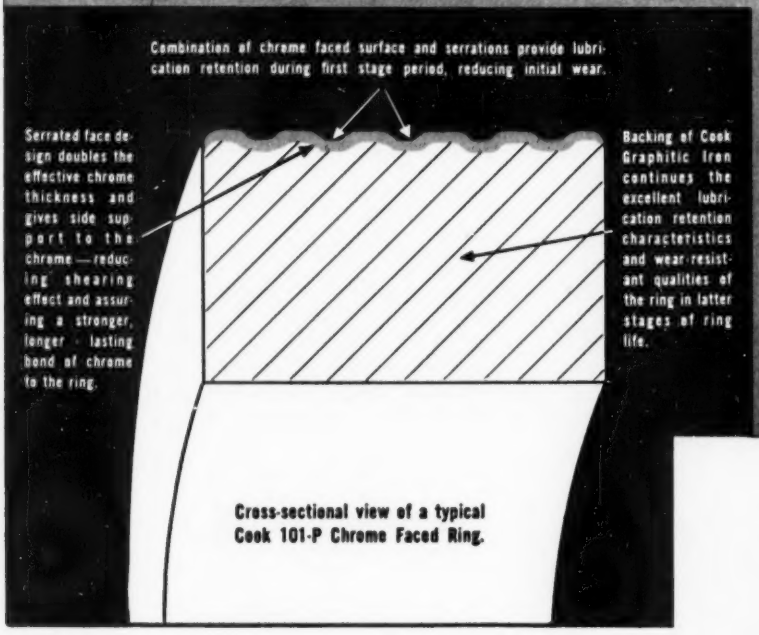
☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

URSA OILS

FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

It costs little to—
GIVE YOUR DIESELS THE EXTRA LONG PROTECTION of
COOK *Chrome Faced* RINGS


Combination of chrome faced surface and serrations provide lubrication retention during first stage period, reducing initial wear.
Serrated face design doubles the effective chrome thickness and gives side support to the chrome—reducing shearing effect and assuring a stronger, longer lasting bond of chrome to the ring.
Backing of Cook Graphitic Iron continues the excellent lubrication retention characteristics and wear-resistant qualities of the ring in latter stages of ring life.

Cross-sectional view of a typical Cook 101-P Chrome Faced Ring.

ALL THE FEATURES OF A CUSTOM-BUILT PISTON RING have been incorporated into the design of Cook Chrome Faced Rings to give you better service, less cylinder wear and longer life. *Yet—they cost no more than ordinary chrome rings!*

It pays to specify Cook Chrome Faced Rings whenever chrome-plated rings are required. They'll rapidly pay for themselves through savings in maintenance and operating expense.

Our field engineers will be glad to show you where and how Cook Chrome Faced Rings can be used to best advantage in your own engines. Call them in. For full information, just fill out the coupon below.

C. LEE COOK MFG. CO., INCORPORATED
Dept. 2, Louisville 3, Ky.

☐ *Please send me more information about Cook Chrome Faced Rings.*

☐ *Please have a Cook Field Engineer call.*

Name_____ Title_____

Company_____

Street_____

City_____ Zone____ State_____

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PISTON RINGS

...SEALING PRESSURES SINCE 1888

DIESEL POWER
AND DIESEL TRANSPORTATION

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October, 1953

Vol. 31, No. 10

Cover Photo: Shows a cylinder boring machine tipped at a 22½-deg angle to permit machining of both banks of an engine frame simultaneously. This production line machine is used in reboring crankcase for rebuilt diesel engines at EMD's La Grange plant.

EDITORIAL

Thoughts on a Bad Brake 37

ARTICLES

GM Series "71" Engine Tune-Up 40
Cleaning—A Part of Maintenance 48
Maintaining Fuel Injection Nozzles 50
Visually Analyzing Bearing Troubles 58
Maintenance Hints from the B & O 64
Nut and Bolt Data Sheet 67
Checking the I-H Injection System 68
Flexible Hoses 73

DEPARTMENTS

Highlights 39
What Do You Know! 47
Straight from the Tool Box 78
Product Previews 80
Field Notes 96
Ad Index 108

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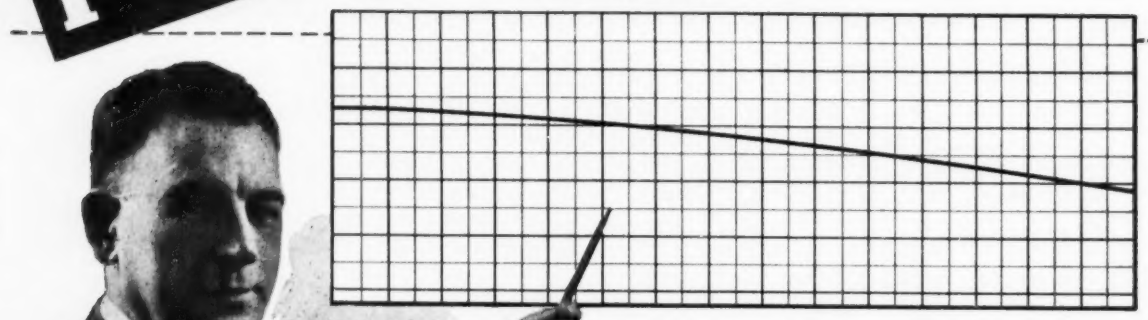
P&H Diesel Engines

(2-CYCLE)

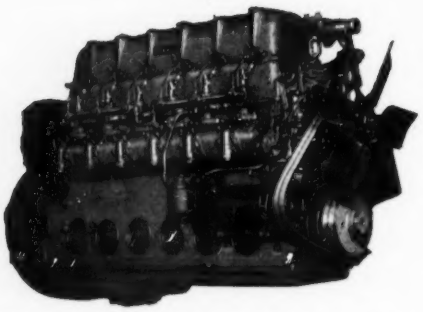


Can your diesels match this torque curve?

This is the torque curve for the P&H Model 687-C Diesel Engine. Note how the torque characteristics are sustained throughout its entire horsepower range.

That means steady, responsive power at all speeds — greater lugging "ability" for those toughest jobs. It's the kind of unfaltering performance that assures more profits in any service, constant or intermittent.

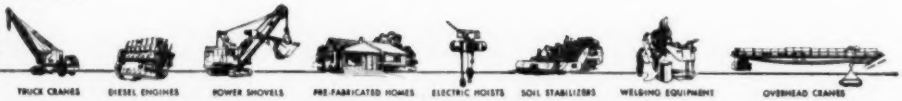
Steady torque for steady work is just another outstanding feature of P&H Diesel Engines — America's most advanced line. Ask your P&H Diesel representative for the full story. Or write for literature.



P&H Diesel Engines are built in 1, 2, 3, 4 and 6-cylinder models — up to 145 h.p.

P&H DIESEL DIVISION
HARNISCHFEGER CORPORATION
CRYSTAL LAKE, ILLINOIS

the P&H *Line*



Here's News on New Profits!

- NEW Profits are yours when you own the NEW Van Norman No. 465. For No. 465 . . . with a capacity of *60"* x *18"* . . . is simplicity itself to operate. And it includes these features:
- NEW Outboard Adjustable Counterweights. Just loosen *one* screw and crank weights up or down. Use scale as a guide. *Operation?* Easiest yet! *Time-saving?* Biggest ever!
- NEW Multiple-Disc Clutch . . . only requires *one* movement of *one* lever to engage work while motor is running.

NEW!

No. 465

- NEW Unit-type Spindle . . . preloaded, prelubricated.
- *6th and NEWEST* in Van Norman's world-famed line of Crankshaft Regrinders. All knowledge gained in 65 years of building heavy duty, precision grinders has gone into the new No. 465.
- NEW No. 465 Carries NEW LOW PRICE for HIGH VAN NORMAN QUALITY!

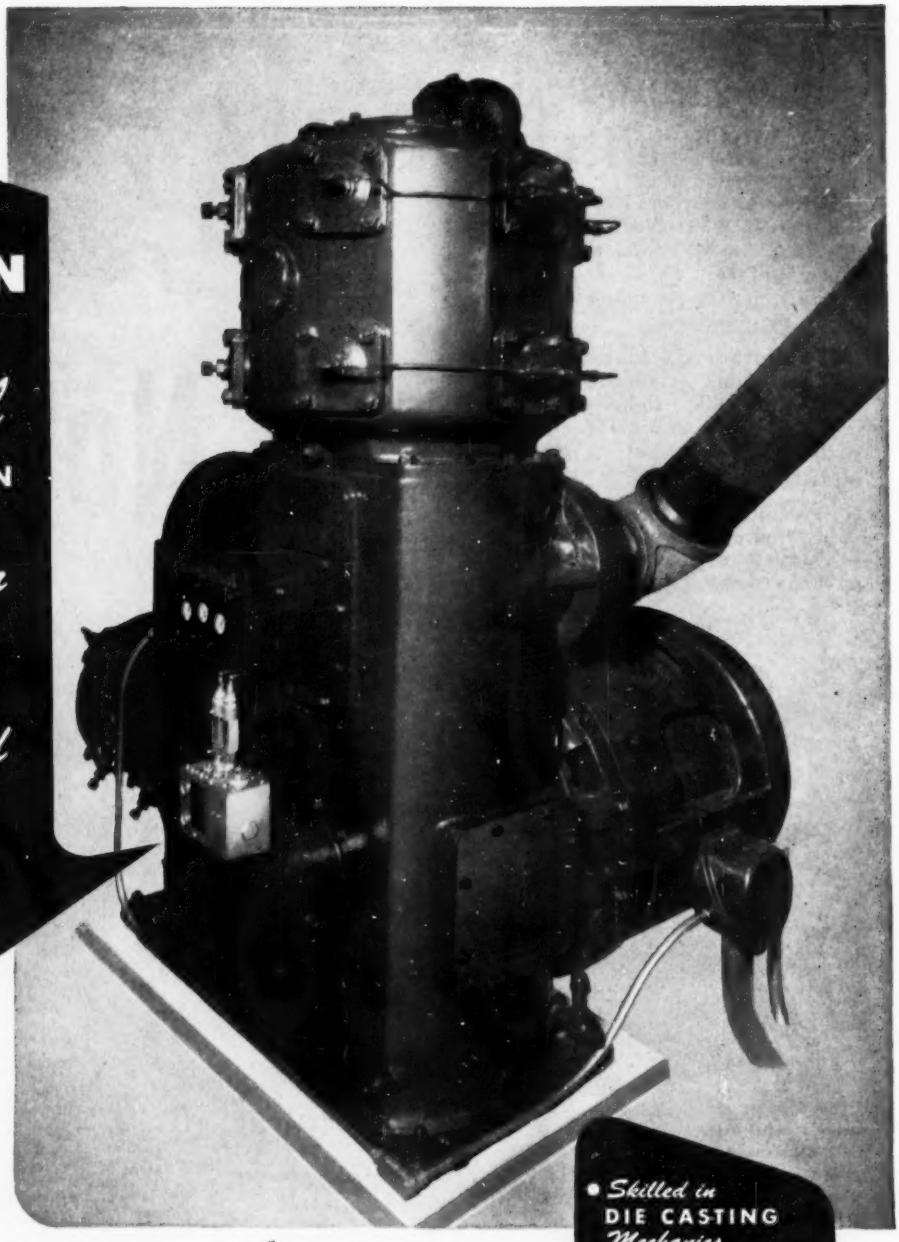
VAN NORMAN Crankshaft Regrinder

VAN NORMAN CO.
Springfield, Mass.
U.S.A.

VAN NORMAN also builds Cylinder Boring Bars (4 models, 3 with vacuum chip-remover) . . . Cylinder Head and Manifold Grinders (2 models) . . . Boring & Grinding Machines for Pistons & Connecting Rods . . . Piston Grinders (2 models) . . . Rotary Surface Grinders for Clutch Plates & Clutch Sides of Flywheels . . . Wet Honing Machines for Cylinder-Wall Refinishing . . . IN SUM, THE WORLD'S MOST COMPLETE LINE OF HEAVY-DUTY AUTOMOTIVE SERVICE EQUIPMENT.

MADISON -KIPP *fresh oil* LUBRICATION

fed under pressure by the measured drop!



Illustrated, the Madison-Kipp Model SVH Lubricator on an Ingersoll-Rand XLE Compressor.

- *Skilled in* DIE CASTING *Mechanics*
- *Originators of Really High Speed* AIR TOOLS
- *Experienced in* LUBRICATION *Engineering*

....STANDARD EQUIPMENT ON COMPRESSORS, WORK ENGINES AND MACHINE TOOLS....

Oil under pressure fed drop by drop from a Madison-Kipp Lubricator will definitely increase the production potential for years to come when applied as original equipment on new machine tools, work engines and compressors. There are six popular models for every application. Write for special engineering data for your particular requirement.

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NOW...

A NEW, MORE POWERFUL GENERAL MOTORS DIESEL THE **TWIN 6-110!**

- ★ Substantially lower cost
- ★ More power from less space and weight
- ★ Torque converter equipped for oil field use

HERE'S General Motors' newest oil field Diesel engine—the power-packed 2-cycle Twin 6-110.

It is 50% more powerful than the famous GM Twin 6-71 that powers more drilling rigs than any other Diesel—yet it has outstanding compactness and light weight. It fits existing compounding case centers.

The new Twin 6-110 gives drillers a wide range of power from a single unit. New dumping type torque converters allow one-engine operation for light load requirements, but the "Twin" power is there when needed.

With Torque Converters, the Twin 6-110 costs 11% less than competitive engine A and 16% less than engine B *without* torque converters in the table below.

	TWIN 6-110	ENGINE A	ENGINE B
Rated H.P.	505	472	460
Continuous H.P.	394	372	375
Width (approx.)	66*	58	66
Length (approx.)	122*	163	92
Height (approx.)	83*	85	108
Weight (approx.)	12,500*	14,080	21,000

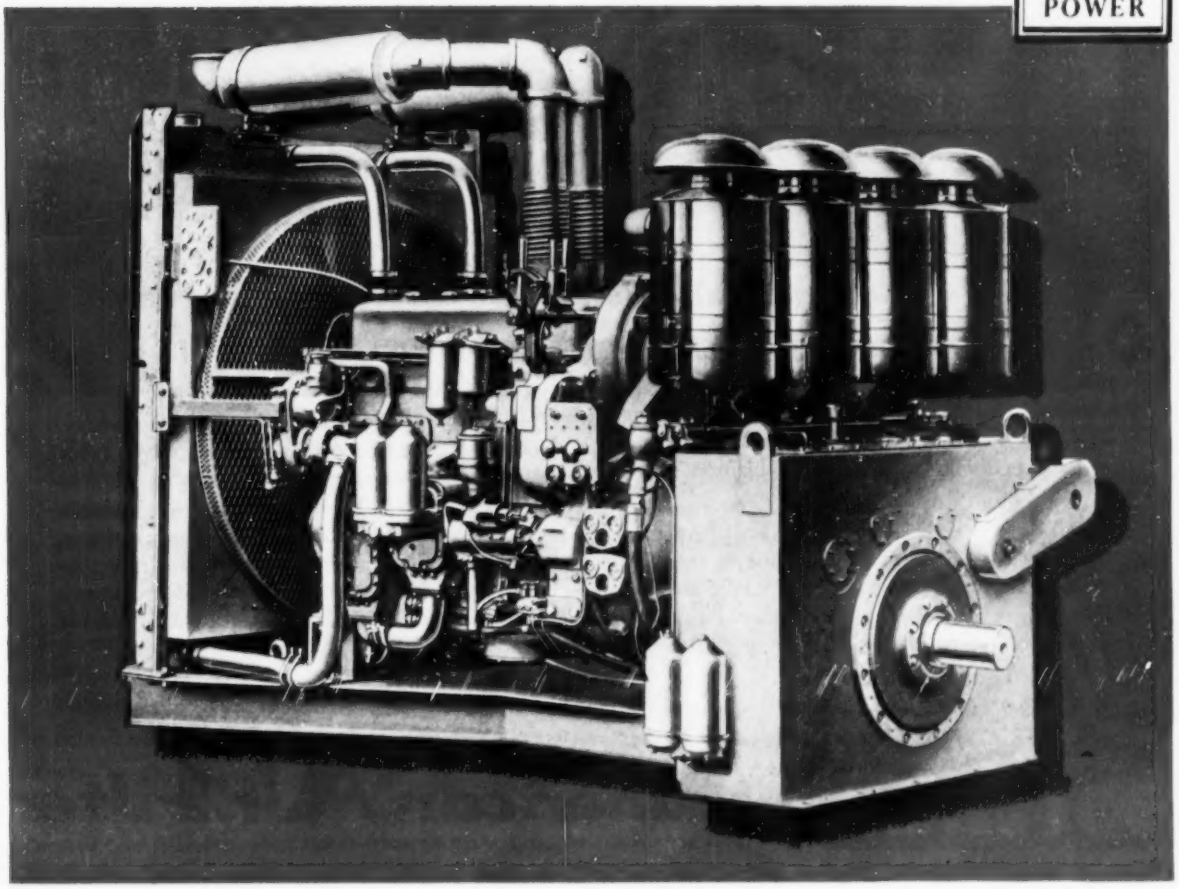
*With Torque Converters. All other figures without Torque Converters.

Get the complete story on General Motors' new Twin 6-110 Diesel from your distributor or supply company, or write us.

DETROIT DIESEL
ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICH.

It pays to standardize on

GM
GENERAL MOTORS
DIESEL POWER



CYCOIL PRESENTS "SOLID FRONT" AGAINST DUST

Compressor station of El Paso Natural Gas, Farmington, N. M. Air intakes to each of four 1350 H. P. Cooper-Bessemer units equipped with Cycoil Oil Bath Air Cleaners.

Infiltration tactics fail against two-way cleaning action of this Oil Bath Air Cleaner!

Dust is a sly and relentless enemy but it's fighting a losing battle here. A Cycoil Oil Bath Air Cleaner at the air intake of each of these 1350 H. P. compressors presents a solid defense against "sneak" or "all out" attack.

Cycoil's two-way cleaning action leaves no room for even a small percentage of dust to reach the engine. Thorough mixing of the intake air traps over 90% of the dust, right at the start. Final cleaning action of the filter pads "mops up" the remaining 10% of fine dust particles that slip by the best of front line defenses.

Your dust protection dollars represent only a small fraction of the investment which they guard. Any air cleaner delivering less than Cycoil's approximate 100% efficiency is only fighting a delaying action—a delay against eventual shutdown for costly repairs caused by dust damage. Write today for complete product information and performance data. Ask for Cycoil Bulletin No. 130.

AAF

American Air Filter

COMPANY, INC.

445 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

EARLY 19TH CENTURY SAWMILL IN EAST TOPSHAM, VERMONT

100-HORSE DIESEL, powered and lubricated with Cities Service Products, is the power plant for Miller's operation.

Industrial Giant?

No, Duncan Miller, Vermont logger (pictured left), is no industrial giant, but his power and lubrication needs are just as vital, and served just as assiduously by Cities Service. Cities Service is proud of its long and successful record serving America's top industrial organizations, but it is equally proud of its record with the "Duncan Millers."

Says Duncan Miller: "I produce some 600,000 board feet of lumber a year. My 100-horse diesel drives all my equipment. I use Cities Service Diesel Fuel because it gives me all the power I need and burns so cleanly to provide easier equipment maintenance.

"In my trucks, tractors, chain saw and sawmill, I use Triple HD Koolmotor Oil. I even use Koolmotor in my high speed bearings that carry heavy loads . . . and Koolmotor has done every job with complete satisfaction for me.

"I also use Cities Service Gasolene in my trucks, tractors and chain saw. I heartily recommend it where a lot of power and economy of operation are needed."

You don't have to be a sawmill operator to realize the value of Cities Service one-source buying for the finest, most economical power and lubrication, and the services of our expert Lubrication Engineers!

FOR SEVEN YEARS, Miller has used only Cities Service Products and *"They have given best results at all times."*

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Why leading diesel engine builders say—

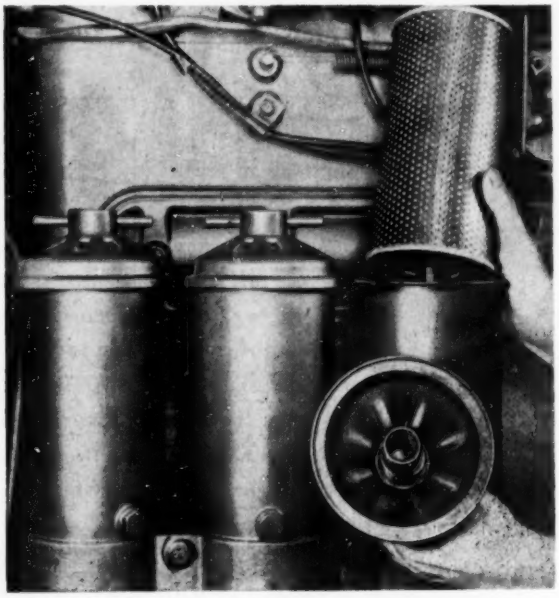
It's *Purolator** for Full-Flow!

- **Full-flow rates within practical filter dimensions:** Purolator's famous "accordion-pleated" Micronic* filter element has up to ten times more filtering area than old-style filters—gives high flow rates in a minimum of space.
- **Ultra-micronic filtration:** High flow rates are, of course, meaningless unless effective filtration is maintained, too. Electron micrographs prove that the Purolator Micronic filter stops particles down to *submicrons*—.0000039 in.!
- **Maximum dirt storage capacity:** The pleated design of the Micronic filter element provides many times more dirt storage space than old-style filters. This important advantage means uniform, efficient performance and a lengthy service life.
- **Minimum pressure drop:** The Purolator Micronic filter element introduces a remarkably small pressure drop in the lubricating system . . . permitting pumps of practical size and simple type.
- **Will not remove or absorb additives:** With Purolator Micronic filtration, you keep *all* the oil quality you pay for. The Micronic filter element will not strip additives . . . an important advantage with HD and heat-resistant oils

Modern engines with full-flow lube systems . . . which filter *all* the oil at each pass through the engine . . . demand the best in filters. And most leading makers of diesel engines and vehicles agree that the best is *Purolator** . . . a fact proved over and over by their own impartial tests.

The story's the same with gasoline engines, too! The world's best known producers of passenger cars, trucks, tractors, earth-moving equipment, and stationary engines have found Purolators best . . . and install them as standard factory equipment.

If you are contemplating new designs or modifications of existing ones, remember . . . there's a well-engineered and use-tested Purolator for *any* filter application, including fuel oil, gasoline, hydraulic fluid, and water. Write for the Purolator catalog issued for your special field.



Purolator Micronic Filters in a typical Diesel full-flow installation. Although the Purolator Micronic filter elements measure only 4½ in. by 9 in., *each one filters 9 gallons of oil per minute*, giving a total of 27 g.p.m. for the complete filter unit.

PUROLATOR PRODUCTS, INC.
Rahway, New Jersey, and Toronto, Ontario, Canada
Factory Branch Offices: Chicago, Detroit, Los Angeles

*Reg. U.S. Pat. Off.

PUROLATOR
MICRONIC OIL FILTER
"FIRST IN THE FIELD OF FILTERING"

Air Starters

save money and weight

Carolina Freight Carriers Corporation was the first to order the New Mack H61T C. O. E. Tractors equipped with Ingersoll-Rand Air Starting Motors. They now have 55 of the new units in service.

Over-the-road carriers everywhere are profiting from increased pay loads by using lightweight Ingersoll-Rand Air Starting Motors in place of the heavy duty electrical systems required for engine starting.

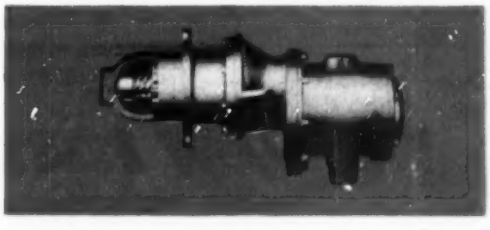
Here are a few of the advantages of Air Starting:

- **Regular air brake compressor provides the starting air.**
- **Tests by freight carriers show better than 50% reduction in starter and electrical system replacement costs.**
- **12 volt system instead of a 24 volt.**
- **Electrical maintenance costs have been reduced as much as 70%.**
- **In an emergency on those down hill grades that run for miles . . . the air supply can be passed into the brake system by a quick opening valve.**
- **Whatever the weather Ingersoll-Rand Air Starters are built to give you ample power for fast, sure engine starting - anywhere.**

Easily Installed—

Mounting Ingersoll-Rand Air Starters is no problem to any mechanic. They are designed for quick installation and minimum maintenance.

Ask your engine distributor to show you the I-R Air Starting Motor line, or write for Bulletin 5094A.



Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

914-18A

WOULD YOU CLEAN ONLY PART OF YOUR FACE?

No, of course, you wouldn't! Then why clean only *part* of the oil in your engine? Why be satisfied with anything less than the best protection you can give your engine's moving parts? Keep *all* your oil clean, and all the moving parts of your engine protected, with warranted Winslow Full-Flow Filters!

WINSLOW FILTERS

Winslow Engineering Company 4069 Hollis Street • Oakland 8, California

...with TYCOL lubricants on hand!

It pays to buy a "Diesel-Designed" Lubricant! ... It takes "something more than a motor oil" to counteract excessive wear in Diesel engines – and we proved it with Tycol Adeltran 40! In this instance, a Diesel engine was operated for one year with a competitive oil. An overhaul by the manufacturer turned up these conditions: all liners had to be replaced as well as piston rings ... 2 top compression rings were stuck and all rings were gummed up. After the switch to Adeltran (for the same operating period) liner wear was negligible ... filter life was considerably extended ... all rings were free and in excellent condition ... and owner reported an exceptionally clean engine base. For full details on Adeltran, contact your local Tide Water Associated office!

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C. • Pittsburgh
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Toronto, Canada

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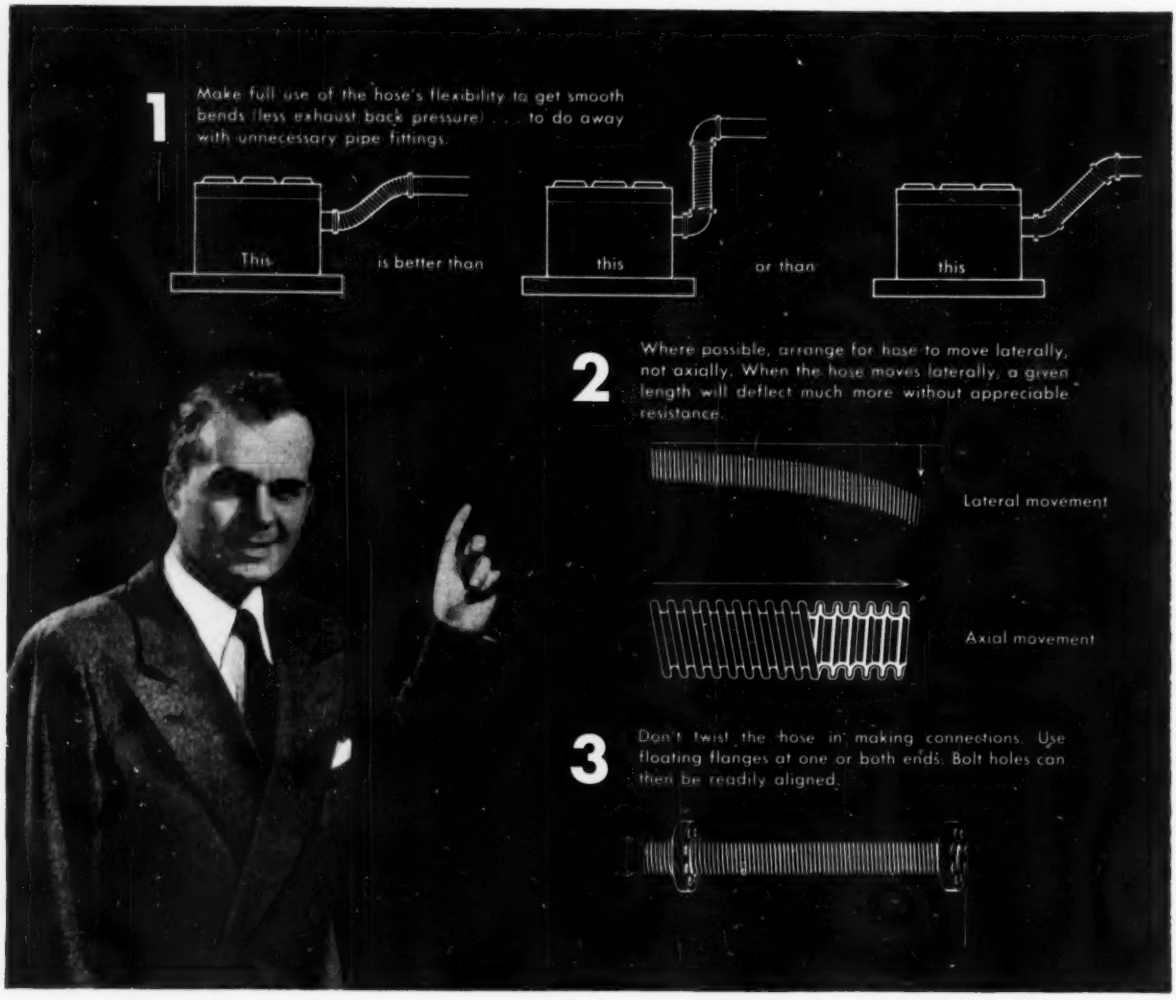
17 BATTERY PLACE - NEW YORK 4, N. Y.

Over 300 Tycol industrial lubricants are at your disposal ... engineered to fit the job!

REFINERS AND MARKETERS OF VEEDOL... THE WORLD'S MOST FAMOUS MOTOR OIL

3 tips on how to install American Flexible Steel Hose in diesel exhaust systems


1
Make full use of the hose's flexibility to get smooth bends (less exhaust back pressure) . . . to do away with unnecessary pipe fittings.
This
is better than
this
or than
this
2
Where possible, arrange for hose to move laterally, not axially. When the hose moves laterally, a given length will deflect much more without appreciable resistance.
Lateral movement
Axial movement
3
Don't twist the hose in making connections. Use floating flanges at one or both ends. Bolt holes can then be readily aligned.

No exhaust system for a diesel engine is *complete* without flexible exhaust hose. Countless actual installations have proven that *American Flexible Steel Exhaust Hose* can "take it" in the day-in day-out grind of carrying hot exhaust gases . . . safely and reliably at low cost.

American Flexible Steel Exhaust Hose absorbs vibration and reduces its transmission . . . allows for expansion or contraction caused by temperature changes in the exhaust lines. There's less chance of overstressing bolts or distorting engine parts.

This hose bends into desired position easily. Its flexibility also simplifies installation when considerable offset is required. Once it's installed, you're sure of years of trouble-free service.

American Flexible Metal Hose for exhaust and air intake—marine or industrial diesels—is available in corrugated steel, 2 in. to 16 in. I.D. inclusive. For full details, write for Bulletin EH-50-1. *The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn. In Canada: The Canadian Fairbanks-Morse Co., Ltd.*

OTHER PRODUCTS FOR DIESEL USE – Flexible tubing with wire braid covering for: starting air, circulating water, fuel oil, lubricating oil. Tubing available in bronze, carbon steel and stainless steel. Assemblies complete with fittings.

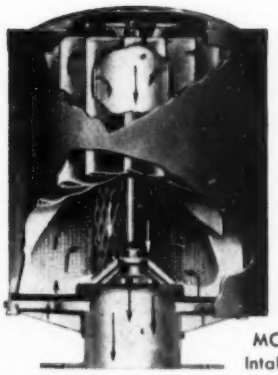
WHEREVER CONNECTORS MUST MOVE

AMERICAN

flexible metal hose and tubing

an **ANACONDA®** product

BEST ENGINE PROTECTION MONEY CAN BUY!



MODEL D
Intake Filter

STAYNEW INTAKE FILTERS

STAYNEW INTAKE FILTERS keep shutdowns and repairs at an absolute minimum. Industrial engineers everywhere know that Staynew's *positive protection* lengthens engine life. They may cost more than ordinary intake filters, but with Staynew, you're assured of engines operating at top performance years longer. Staynew Intake Filters' extreme efficiency protects vital engine parts without carefully held maintenance schedules. And, efficiency actually increases with use. They're efficient over a wide range of loads, not affected by temperature changes, there's no oil carry over and no oil blow-out on free air unloading compressors. To keep equipment young *longer*, always specify Staynew.

Write today for Intake Filter Bulletin S.I.F.

Representatives in Principal Cities

DOLLINGER
PROTECTO-MOTOR
STAYNEW FILTERS

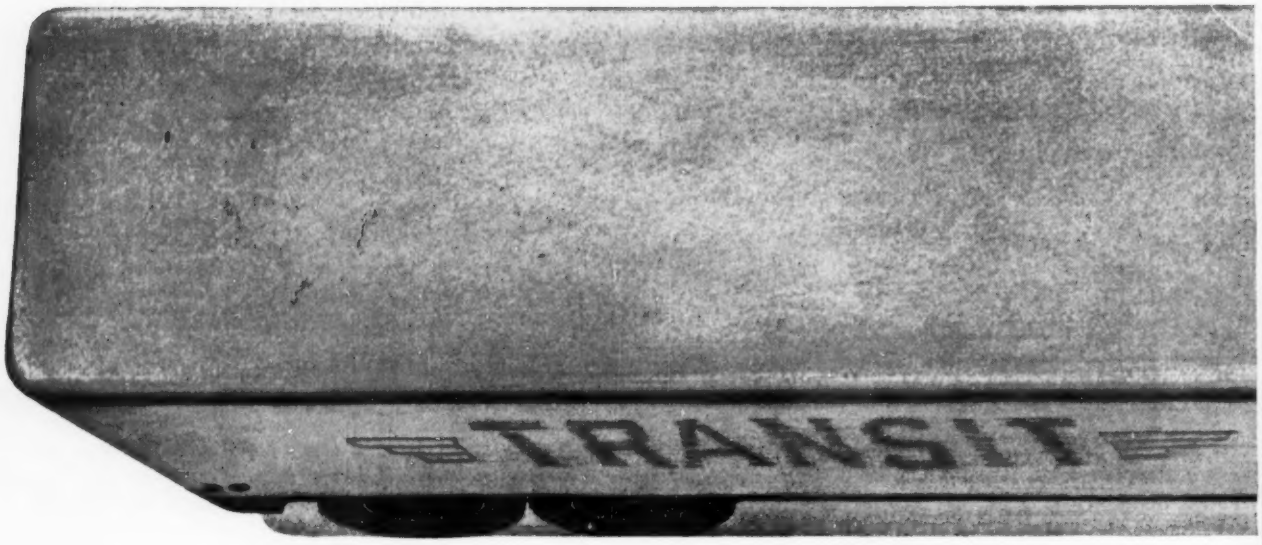
DOLLINGER
CORPORATION

10 Centre Park Rochester 3, N. Y.

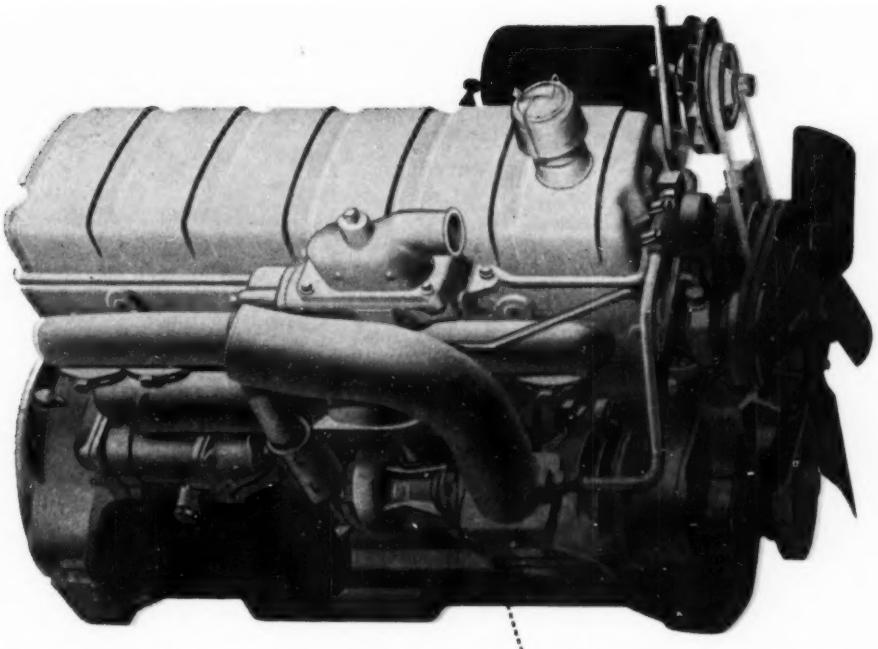
ALL TYPES OF FILTERS
FOR EVERY INDUSTRIAL NEED

If you operate medium heavy-duty trucks ...

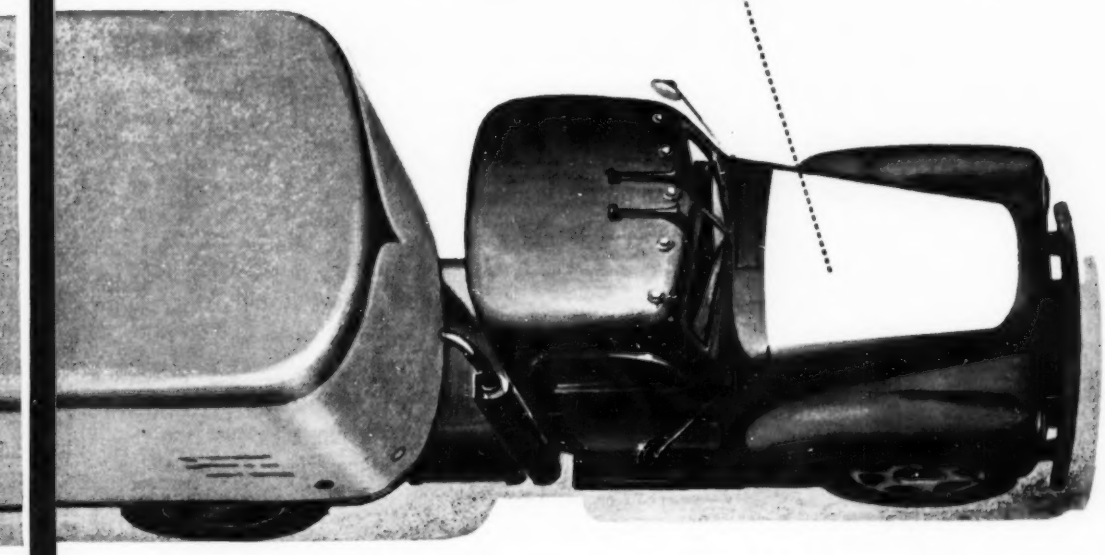
This new 150 h.p. diesel <u>now</u> makes Cummins



CUMMINS



performance and economy available to you



It's Cummins new Model JBS-600—ready to serve in the medium heavy-duty trucks produced by leading manufacturers. Ready to bring to this field the performance that has made Cummins the leader among high-output diesels. 150 h.p., the JBS-600 delivers full rated power for faster acceleration . . . for reserve stamina when the going is tough.

JBS-600 operators report more miles per gallon . . . lower fuel costs. This demonstrates the fact that Cummins' exclusive fuel and injection system—together with four-cycle operation and use of inexpensive Number 2 diesel fuel—naturally leads to savings on the job. The JBS-600 is ready to work profitably for you. It's Cummins-engineered for a long and useful life.

For all the facts—see your Cummins dealer!

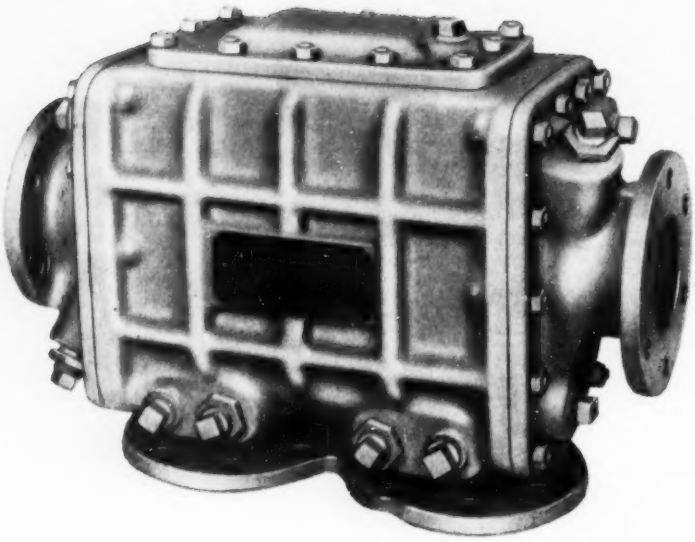
Cummins®

Engine Company, Inc. • Columbus, Indiana

Leaders in rugged, lightweight, high-speed diesel power

LOOK TO HARRISON

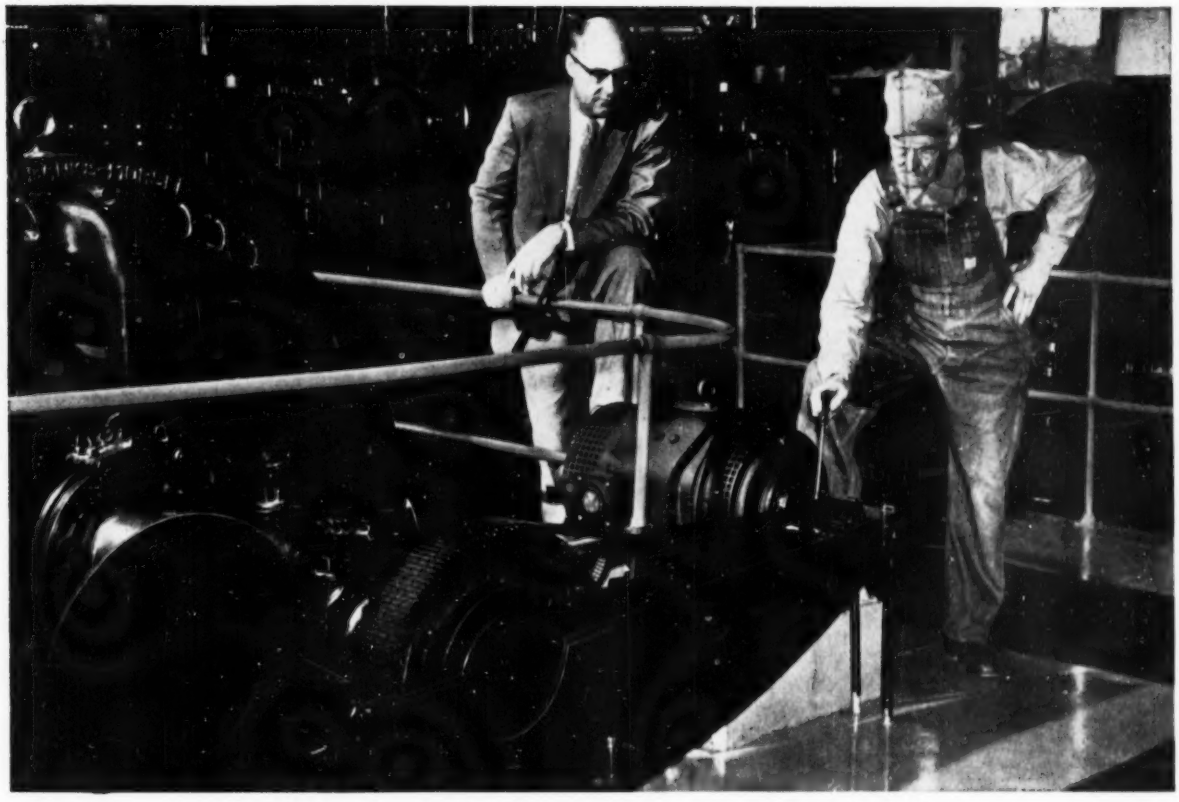
for dependable heat exchangers



HARRISON
RADIATOR DIVISION
GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK

Diesel engines must operate within a specific temperature range if they are to deliver the performance that has been built into them. And Harrison heat exchangers, by providing efficient cooling of jacket water and lube oil, insure the proper operating temperatures. Harrison has been designing and building heat transfer products for more than forty years, and the knowledge gained from this experience qualifies us to be of service to you. We welcome the opportunity to discuss your requirements.

HARRISON



Link-Belt Silent Chain Drive operates the exciter on this 840 kw Fairbanks-Morse generator in Kansas. Two other drives operate at 375 kw and 781 kw.

LINK-BELT Silent Chain Drives transmit full exciter rpm

Positive tooth-to-tooth action provides exact ratios for drives which give long, efficient service on diesel auxiliary drives

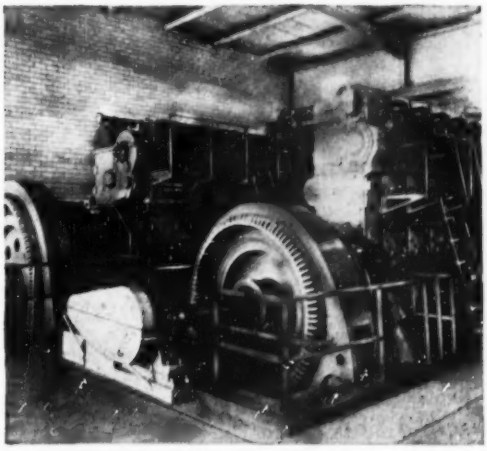
LINK-BELT Silverstreak Silent Chain does not rely on tension for its pulling power. The chain meshes with the sprocket teeth —gives you a positive drive—no slippage.

That's one big reason why so many diesel-generators have Link-Belt Silent Chain exciter drives. Another is its compact, all-metal construction. The long life of Silverstreak Silent Chain is a matter of record. Twenty-five years' service—with no maintenance other than routine lubrication—is regularly achieved.

If you're installing exciter or any other diesel auxiliary drives —check up on Link-Belt Silent Chain. There's an experienced power transmission engineer in the Link-Belt office near you.

LINK-BELT

SILVERSTREAK SILENT CHAIN DRIVES



At this Iowa station, the Link-Belt Silent Chain Exciter Drive transmits full rpm to a 1600 kw Elliot generator.

LINK-BELT COMPANY—Plants: Chicago, Indianapolis, Philadelphia, Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities. 12,000

Exide

XF HEAVY-DUTY BATTERIES

For dependable diesel starting—lower operating costs

OUTSTANDING FEATURES

NEW GRID ALLOY • NEW ACTIVE MATERIAL—G.O.X.
LOWER OPERATING GRAVITIES • NEW DUAL INSULATION

WITH XF BATTERIES YOU GET:

EXTRA LONG LIFE. Longer than you ever thought possible.
QUICK BREAKAWAY and fast acceleration of engine to firing speed.
RUGGED CONSTRUCTION for rough usage in hard service.
LOW COSTS of operation and maintenance.

Now, more than ever before

EXIDE IS YOUR BEST BATTERY BUY... *AT ANY PRICE*

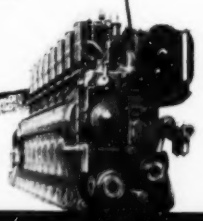
1888
DEPENDABLE BATTERIES FOR 65 YEARS
1953

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 2 • Exide Batteries of Canada, Limited, Toronto

We take the JITTERS out of Diesel Operation

Check these points on smooth, quiet-running ENTERPRISE Diesels

- ✓ All ENTERPRISE crankshafts are built to meet and exceed the requirements of Lloyds, the American Bureau of Shipping and other rating agencies.
- ✓ Main bearings are concentric within .002 total indicator movement.
- ✓ Crankpin bearings are parallel with main bearings within .0005 in length of bearing
- ✓ Variation from true cylinder on main and crankpin bearings do not exceed .0005.
- ✓ Surface finish of all bearings is 10 Mu. In. R. M. S. Max.
- ✓ The high quality and reliable performance of ENTERPRISE crankshafts is typical of every component part of every ENTERPRISE Diesel—your assurance that there is NOTHING FINER IN HEAVY-DUTY DIESELS!



ENTERPRISE True-Balanced Crankshafts are *"super-finished"* to precision tolerances for a smoother running engine

Through every phase of production and testing, nothing is spared to prepare ENTERPRISE Diesel crankshafts for the long, trouble-free service expected of them. That's why they are forged from single "pedigreed" ingots, then fully annealed to make them resistent to fatigue or shock loads. That's why they are precision machined *completely* —for exacting control of balance, with journals and crank pins *"super-finished"* to micro tolerances. That's why they are oversize, with heavy cross-sections to reduce operational stresses, increase rigidity, decrease unit bearing loads.

And that's why every engine is given a thorough torsional analysis to help determine proper selection of flywheel, couplings and shafting which checks vibration and insures smooth engine operation.

Here is another of the many plus values enjoyed by ENTERPRISE customers the world over. Get all the facts, and *your* choice, too, will be ENTERPRISE.

Write for descriptive bulletins, or call your nearest ENTERPRISE *Diesel Sales office.*

GENERAL METALS

Enterprise DEPENDABLE Diesels

ENTERPRISE ENGINE & MACHINERY CO.

18th & Flordia Streets, San Francisco 10, California

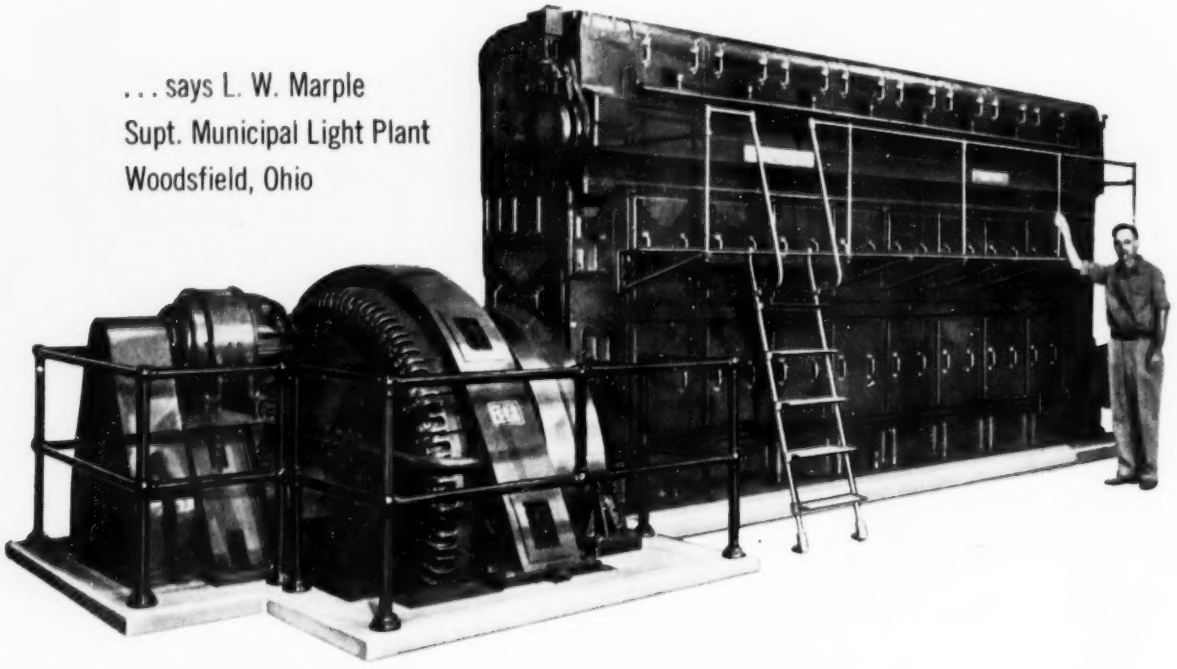
A SUBSIDIARY OF GENERAL METALS CORPORATION

Boston · Chicago · Denver · Ft. Worth · Kansas City · Los Angeles
New Orleans · New York · San Diego · San Francisco
Seattle · St. Louis · Washington, D. C.

DIESEL ENGINES • OIL BURNERS • PROCESS MACHINERY

"No More Sticking Rings..."

... says L. W. Marple
Supt. Municipal Light Plant
Woodsfield, Ohio



● "Because of the lubricating oil we were previously using," says Mr. Marple, "sticking rings and carbon build-up were persistent problems on our three Fairbanks-Morse Model 32-E diesels.

"Three years ago, at the recommendation of one of your lubrication engineers, we switched to Sinclair GASCON® Oil D – HD.

"GASCON D – HD has cleared up our troubles... no more sticking or broken rings... no more carbon build-up, even though our load factor has increased. The result is a considerable savings in maintenance costs.

"We are also getting outstanding results with GASCON in our new 875 H.P. National Superior Dual Fuel Engine."

Perhaps a Sinclair Lubrication Engineer can solve *your* lubrication problems. Call your local Sinclair Representative or write to Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

SINCLAIR

DIESEL

LUBRICANTS

save wear and replacements

Synchronized Power

writes earth-moving success story

One of Roy Kohl's five scrapers hauling a 24-yard load at Lockbourne Air Force Base. On this 212,000-yard job, the scrapers load in 90 seconds and travel to the spreading site at 30 mph.

In 1949, Roy Kohl was a basement excavating contractor in Ohio. During the last four years he has changed his operation and has moved more than 2½ million yards of ore, earth and clay on many types of big jobs.

His success story is built around the operation of 5 tandem-engine Euclid scrapers. The tandem-engine application—one pulling and one pushing—was made possible by Allison TORQMATIC DRIVES which synchronize the power of both engines through a simple control.

Kohl, like other operators, has found that Allison matched Torque Converters and hydraulic Transmissions contribute many ways to the more successful use of heavy-duty equipment. Most important, of course, is the ease of operation; the engines' ability to work at peak efficiency; and the cushioning effect which eliminates harmful shock on engines and the entire drive line.

Kohl reports his "Eucs" operate under all conditions, and climb up to 50% grades under full load. The five units now average over 2,000 hours a year. His first scraper moved more than a million yards without any major maintenance on Converter or Transmission.

Your dealer can give you more information about low-cost equipment maintenance where Allison TORQMATIC DRIVES are installed or you may wish to write Allison direct for full particulars.

ALLISON DIVISION OF GENERAL MOTORS
Box 894SS, Indianapolis 6, Indiana

ALLISON TORQMATIC DRIVES

Unbeatable Team for Maximum Operating Economy

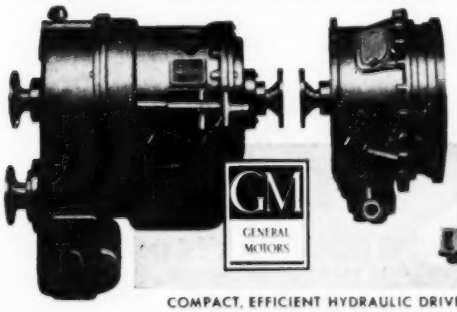
* *Quick-shifts* at full throttle with fingertip hydraulic control.

* *Holds* power to load at all times—no clutch pedal to push—no gearshift guess.

* *Cuts* maintenance cost by absorbing shock—eliminates engine lugging—prolongs equipment life.

* *Only* torque converter-transmission team designed to work as a unit and built by one manufacturer.

FIRST MATCHED UNITS BUILT BY ONE MANUFACTURER.

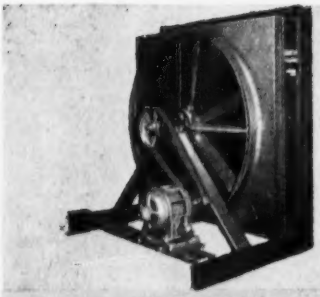


Allison TORQMATIC DRIVES

COMPACT, EFFICIENT HYDRAULIC DRIVES FOR CRANES • TRUCKS • TRACTORS • SCRAPERS • SHOVELS • DRILLING RIGS

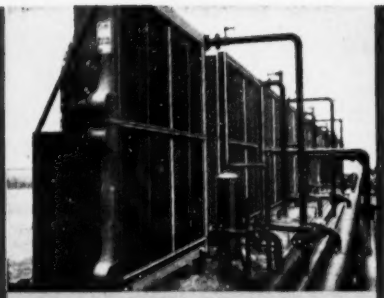
Use Them Individually or in Combination...

YOUNG HEAT TRANSFER PRODUCTS
Are ALL Engineered to Work Together



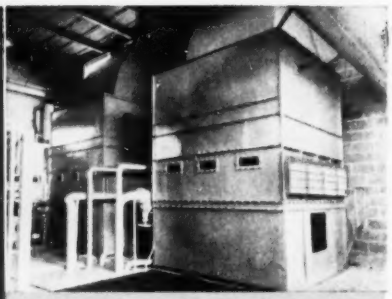
"Mono-Weld" Jacket Water Coolers

Rugged, welded-steel construction assures maximum strength with minimum weight for stationary or semi-portable equipment. Core sections readily replaceable. Tanks easily removed for cleaning.



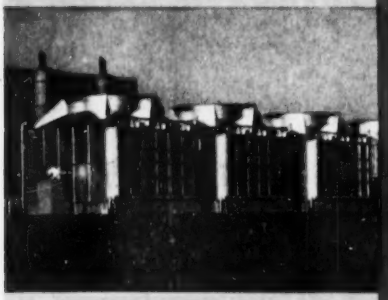
"Full-Flow" Jacket Water Coolers

Sturdy, welded-steel frame with specially-designed Young "Full-Flow" cast tanks. Flexible mountings absorb vibration, allow for expansion and contraction. Tanks easily removed for cleaning.



Evaporative Cooling and Condensing Units

Self-contained units in six basic models, with single or two-coil assemblies. Sectional design provides versatility, ease of handling. Used primarily for cooling Diesel engine jacket water and lube oil.

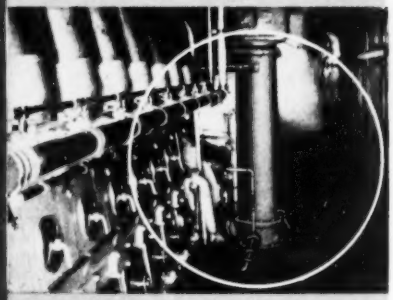


"VAD" Cooling and Condensing Units

Vertical air discharge permits compact multiple unit installations without loss of efficiency due to cross winds. Low-level mounting, low-cost installation, easy inspection and maintenance are features.

"HC" Cooling and Condensing Units

Horizontal core construction with vertical air discharge. Rugged structural design; wide choice of cores; complete with fans, power plants and controls. In single or multiple type units.

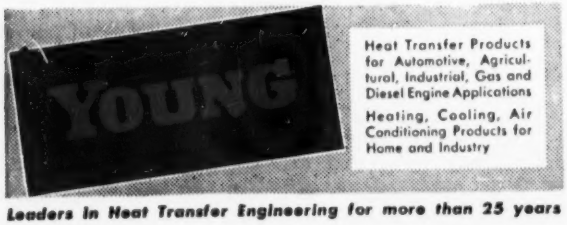


Shell and Tube Heat Exchangers

Available in 690 standard models, single to four-pass, fixed and removable tube bundles. Unusually close-tolerance construction assures maximum cooling with minimum weight. Calculator available.

YOUNG RADIATOR COMPANY

Dept. 413-K, Racine, Wisconsin
Plants at Racine, Wisconsin and Mattoon, Illinois

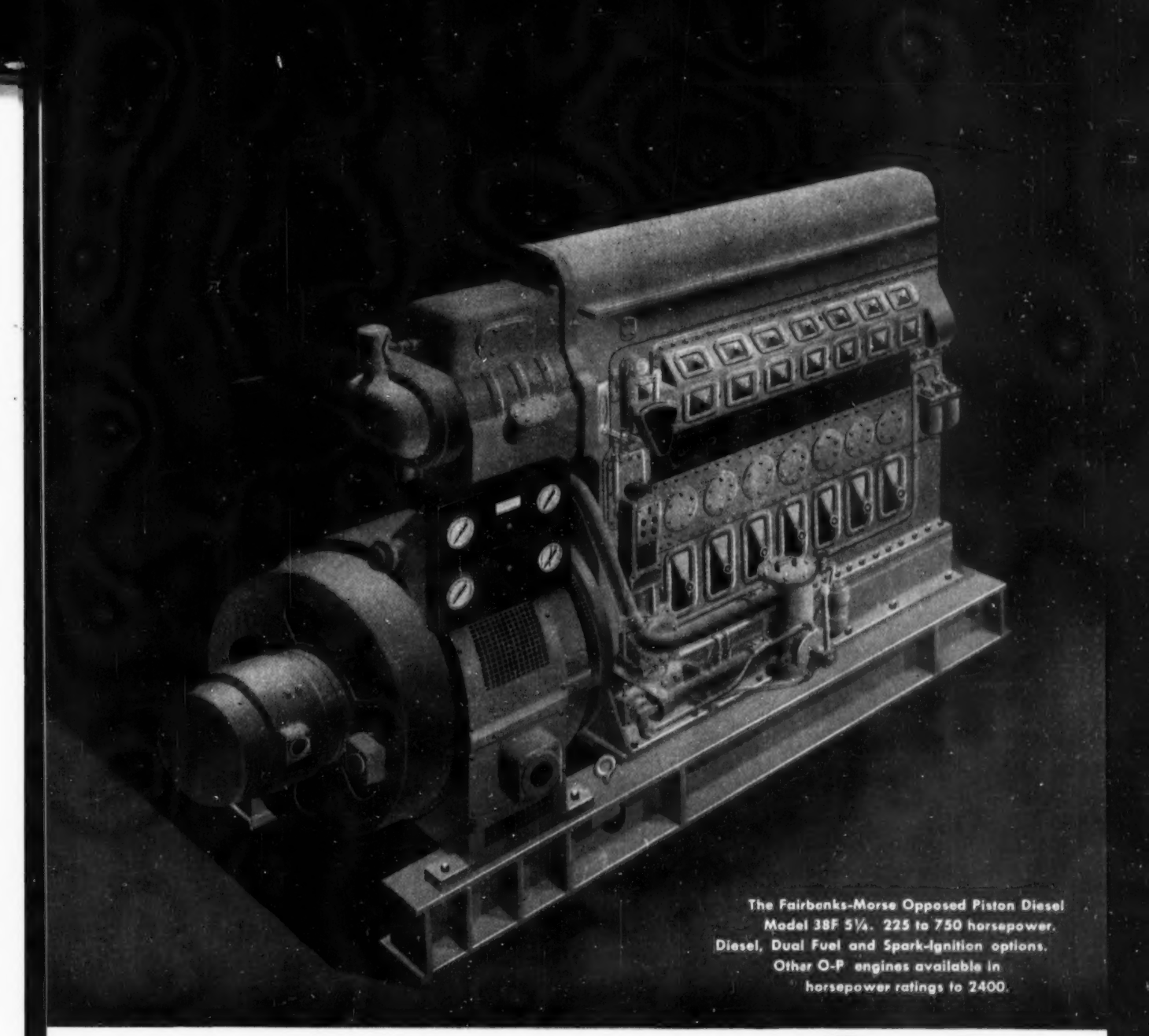

YOUNG
Heat Transfer Products for Automotive, Agricultural, Industrial, Gas and Diesel Engine Applications
Heating, Cooling, Air Conditioning Products for Home and Industry

Leaders in Heat Transfer Engineering for more than 25 years

For a full picture of the complete Young Line of heat transfer equipment, write for a free copy of General Catalog No. 148. For more detailed information on any of the products shown above, please state which products interest you most, and a complete catalog will be sent without obligation.

YOUNG RADIATOR COMPANY

Dept. 413-K, Racine, Wisconsin
Plants at Racine, Wisconsin and Mattoon, Illinois



The Fairbanks-Morse Opposed Piston Diesel
Model 38F 5¼. 225 to 750 horsepower.
Diesel, Dual Fuel and Spark-Ignition options.
Other O-P engines available in
horsepower ratings to 2400.

...always a need for something *Finer*

It was designed and built without thought of price... built only to give the maximum of heavy-duty horsepower in a minimum of space... plus an unvarying reliability upon which you could stake a balance sheet of operating costs and profits.

The price?

Not quite as low as conventionally designed and conventionally manufactured engines, but low enough to insure that no one who wants and needs an engine which gives more, need forego its ownership. For the more difficult tasks of producing power, this engine is a fulfilling answer.

Fairbanks, Morse & Co., Chicago 5, Illinois.

FAIRBANKS-MORSE
a name worth remembering when you want the best

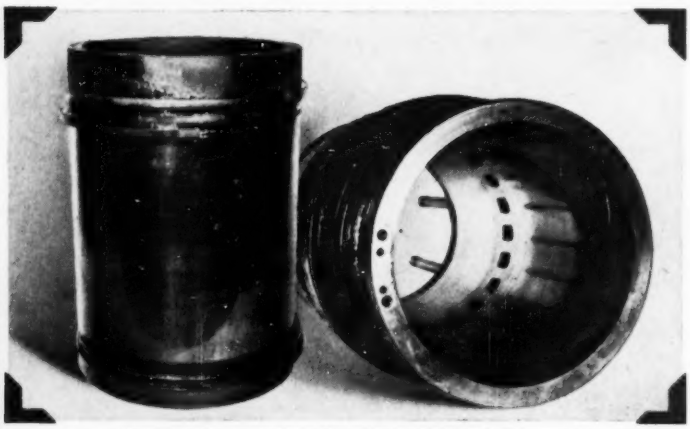
DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • RAIL CARS • ELECTRICAL MACHINERY • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

THE ENGINEER'S REPORT

DATA

LUBRICANT	RPM Delo Oil R.R.
UNIT	Diesel locomotive
SERVICE	Transcontinental freight—grades to 1.8%
PERIOD	3 years
LOCATION	Minneapolis, Minn., to Wenatchee, Wash.
FIRM	Great Northern Railway

504,851 freight miles in 3 years without overhaul!



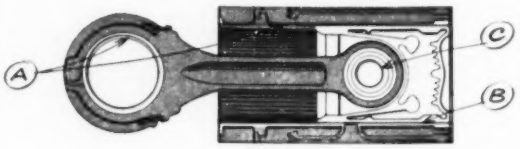
ONLY 0.002 INCH WEAR was miked on liners of this locomotive's engines when they were inspected after 504,851 actual miles. Lubricated with RPM DELO Oil R.R., the engines operated without trouble of any kind during 3 years of tough service hauling freight over the Continental Divide. Representative piston and liner, above right, shown as they appeared when taken from one of the engines, demonstrate good condition of parts after this extended service. All rings were free when engine was torn down. Overhaul was performed only because of time and mileage on engine, which was estimated to have idled the equivalent of 100,000 miles in addition to actual mileage. Besides low wear of liners, other wear measurements (inches) were only: Wrist Pin—0.001; Wrist Pin Bushing—0.0015; Carrier Bushings—0.0015; Oil Ring—0.003.

REMARKS: Great Northern Railway's diesels haul heavy freight up grades as severe as 1.8%. Engines operate in dust and heat in summer, snow and extreme cold in winter.

FREE CATALOG: "How to Save Money on Equipment Operation," a booklet full of valuable information, will be sent you on request to Standard Oil Company of California, 225 Bush St., San Francisco, Calif.

RPM DELO LUBRICATING OILS

How RPM DELO Oil R.R. prevents wear, corrosion, oxidation



A. Special additive provides metal-adhesion qualities...keeps oil on parts whether hot or cold, running or idle.

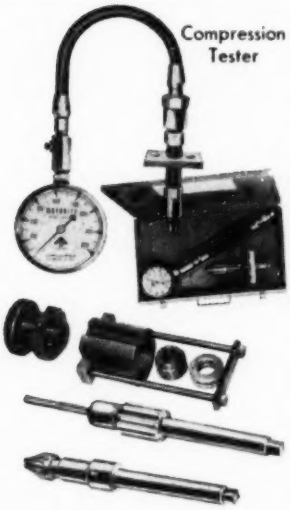
B. Anti-oxidant resists deterioration of oil and formation of lacquer...prevents ring-sticking. Detergent keeps parts clean...helps prevent scuffing of cylinder walls.

C. Special compounds stop corrosion of any bushing or bearing metals and foaming in crankcase.

FOR MORE INFORMATION about this or other petroleum products of any kind, or the name of your nearest distributor handling them, write or call any of the companies listed below.

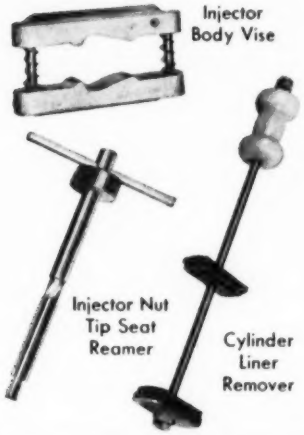
STANDARD OIL COMPANY OF CALIFORNIA, San Francisco 20 • STANDARD OIL COMPANY OF TEXAS, El Paso
THE CALIFORNIA OIL COMPANY, Barber, New Jersey • THE CALIFORNIA COMPANY, Denver 1, Colorado

BACHARACH DIESEL TESTERS and SERVICE TOOLS



Compression Tester

Injector Tube Reamer Set



Injector Body Vise

Injector Nut Tip Seat Reamer

Cylinder Liner Remover

Compression Tester

Especially designed for Diesel engines. Reads up to 800 psi. Motorite Tester is easy to connect to any make and model of Diesel engine merely by removing the nozzle or injector and installing the proper Motorite Adapter in its place. Shown at left is Motorite Tester with "Universal" Style Adapter D-505 which is adjustable to serve more than 100 different makes and types of Diesel engines. Carrying Case has room for 4 additional adapters. A large assortment of adapters is regularly carried in stock.

Send for Bulletin 643

Nozzle Cleaning Tools

These cleaning tools are available in different assortments made up in accordance with engine builders' specifications. Included are cleaning needles, twist drills, pin vises, reamers, brushes, lapping blocks, lapping compounds and other specially designed cleaning tools. Each assortment is furnished as a completely packaged unit. For information on any specific assortment, give make of engine and brand name of fuel injection nozzle.

Send for Bulletin 631

Nozzle and Injector Testers

Equipment is available in a self-contained "Universal" assembly for testing American Bosch nozzles as well as Cummins and GM Injectors as shown in the illustration below, or may be purchased selectively for testing a particular type or related group of nozzles or injectors. This equipment meets the long felt need for compact, simple and economical testing means for field and shop use. It is easy to handle, making it ideally suited for field service trucks and temporary shops; yet it has the rigidity and stamina to stand up under continuous service duties of large repair shops and service centers rebuilding nozzles or injectors in quantity. Each group assembly has been engineered to meet fully the requirements necessary for testing the particular nozzles or injectors in accordance with manufacturer's recommendation.

Send for Bulletin 630-48

GM "71" Service Tools

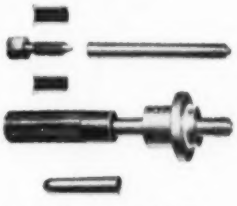
A complete line of tools essential for specialized service operations on GM "71" Diesel Engines. Each tool has been engineered to perform a specific service job which can not be done properly with general shop equipment. These tools provide servicemen with dependable and accurate means to service GM "71" Diesels quickly and efficiently in accordance with the manufacturer's recommendations.

Send for Tool Cat. 52

Nozzle Cleaning Set

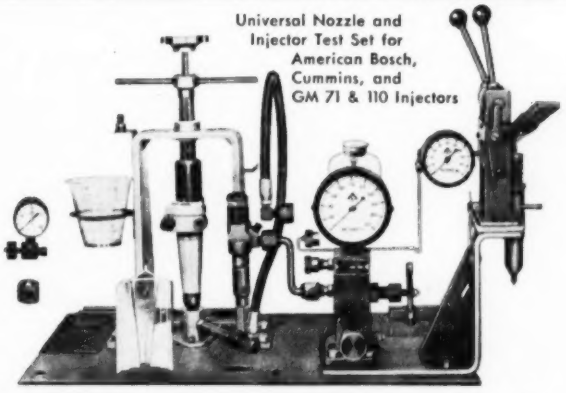
Valve Seat Insert Remover

Nozzle and Injector Lapping Block



Fuel Pump Service Set

Engine Dolly for GM "71" Diesel Coach Power Plants



Universal Nozzle and Injector Test Set for American Bosch, Cummins, and GM 71 & 110 Injectors

The equipment shown on this page can be obtained from your jobber.

BACHARACH INDUSTRIAL INSTRUMENT CO.
7301 PENN AVE., PITTSBURGH 8, PA.

MAIL THIS COUPON NOW

GM-3e

Bacharach Industrial Instrument Co., 7301 Penn Ave., Pittsburgh 8, Pa.

☐ *Send quotation on the following equipment:*

Send copies of literature checked:

☐ BUL. 643 ☐ BUL. 631 ☐ BUL. 630-48 ☐ CAT. 52

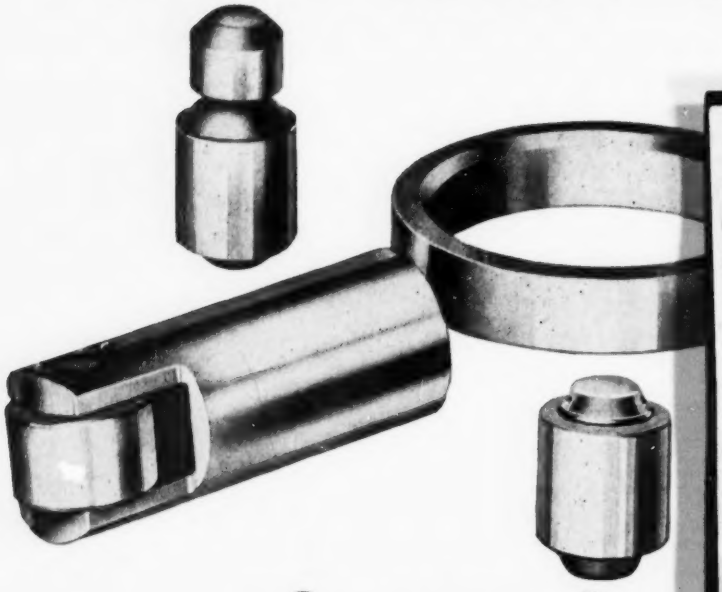
Name _____

Company _____

Street _____

City and State _____

Eaton Parts for Diesel Engines



have a bac
years of cooperati
Diesel industry

WAY

PAC

Eaton is proud to have served as supplier to leading Diesel engine manufacturers for many years—furnishing valves, free-valves, lash adjusters, valve seat inserts, cam followers, bolts, studs, and other precision parts. This close cooperation with the Diesel industry has given Eaton engineers a thorough understanding of the requirements of specific engines, so essential in solving valve-train and other problems.

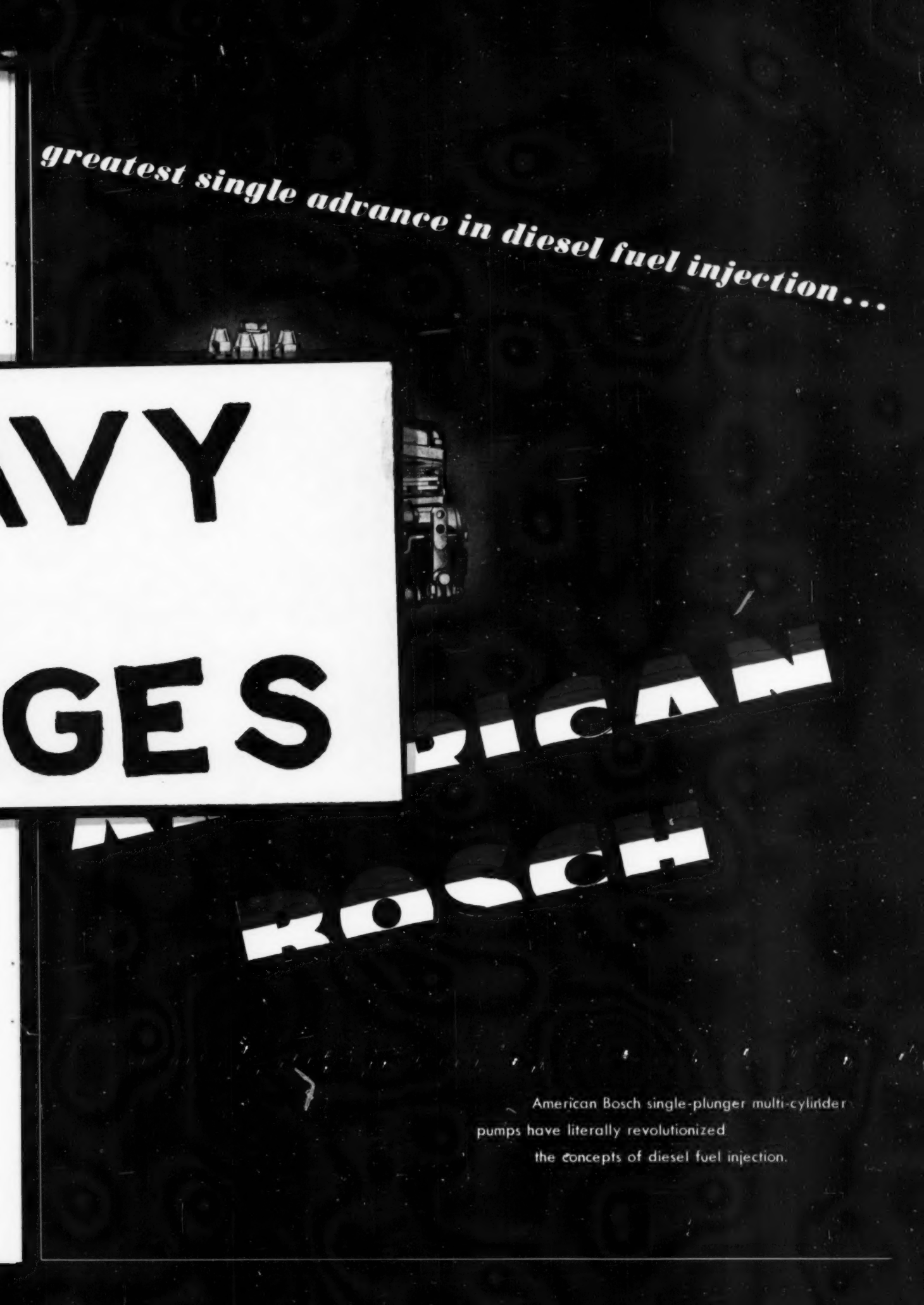
EATON MANUFACTURING COMPANY

CLEVELAND, OHIO

SAGINAW DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

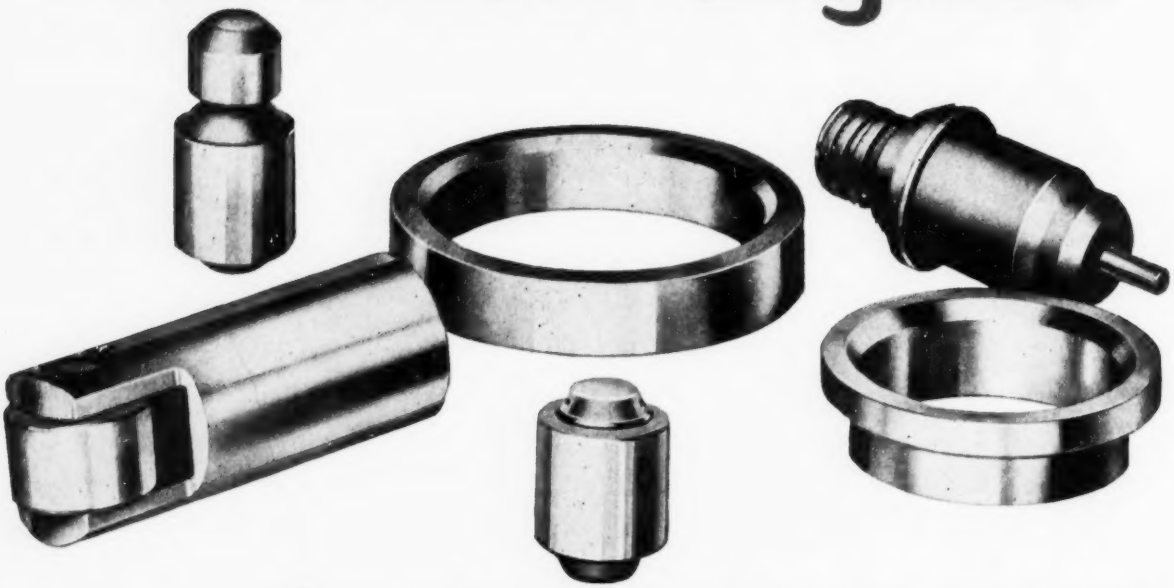
PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

greatest single advance in diesel fuel injection...



American Bosch single-plunger multi-cylinder pumps have literally revolutionized the concepts of diesel fuel injection.

Eaton Parts for Diesel Engines



have a background of years of cooperation with the Diesel industry

Eaton is proud to have served as supplier to leading Diesel engine manufacturers for many years—furnishing valves, free-valves, lash adjusters, valve seat inserts, cam followers, bolts, studs, and other precision parts. This close cooperation with the Diesel industry has given Eaton engineers a thorough understanding of the requirements of specific engines, so essential in solving valve-train and other problems.

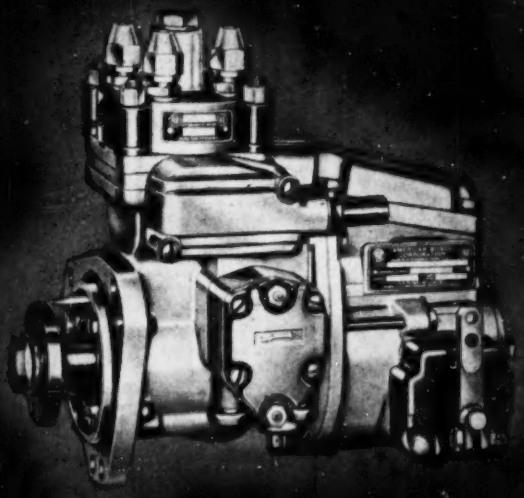
EATON MANUFACTURING COMPANY

CLEVELAND, OHIO

SAGINAW DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

greatest single advance in diesel fuel injection...



AMERICAN BOSCH

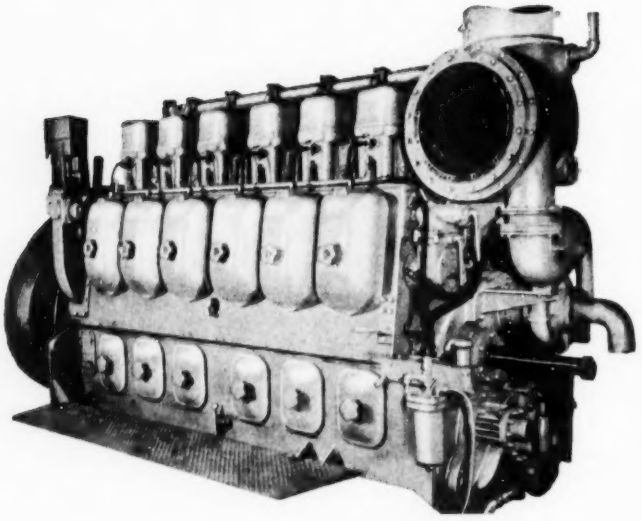
American Bosch single-plunger multi-cylinder pumps have literally revolutionized the concepts of diesel fuel injection.

Presenting...

the heavy-duty, lightweight

ALCO 251-A

all-purpose diesel engine



ALCO 251-A SPECIFICATIONS

Size: 6-cylinder
Bore: 9"
Stroke: 10½"
Cycles: 4 turbocharged
Horsepower: 690
Rpm: 900
Net weight (engine only):
21,350 lb dry;
22,500 lb wet

TYPICAL APPLICATIONS

Oil-well drilling rigs
Crude oil pipeline pumping
Products pipeline pumping
Gas pipeline pumping
Electric power generation
Irrigation pumping
Dredging
Portable units mounted on skids, trailers, rail cars

The Alco Model 251-A—an in-line, 9 x 10½-in. diesel engine designed for a variety of stationary or portable uses in continuous or standby service—incorporates Alco engineering and experience gained in the manufacture of the famed "244" V-12 and V-16 engines of the same bore and stroke. The 251-A combines heavy-duty output with light weight, ease of maintenance, and low operating costs.

Special Features Include:

★ Engine base and frame of structural steel—lighter weight permits lighter, more economical foundations.

★ Compact design (11 ft 5 in. long, 4 ft 11 in. wide)—saves floor space.

★ All wearing parts easily accessible.

★ Lube oil sump, pump, cooler and strainers, and circulating water pump, are integral parts of engine—for low installation cost.

★ Arranged for Dual Fuel by *adding* parts—not by replacing parts or rebuilding engine.

★ Started by air motor, on as little as 60 lb air.

★ Free end has extension driveshaft for auxiliaries (radiator fan, air compressor, etc.).

Additional details are given in Bulletin DE-2, which your nearest Alco sales representative will be happy to send you, along with complete information in terms of your own specific requirements. Contact him at New York, Beaumont, Chicago, Cleveland, Houston, Kansas City, San Francisco, Schenectady or St. Louis.

Alco THE MARK OF MODERN ENGINEERING

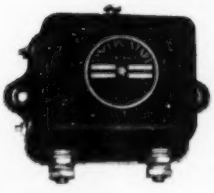
ALCO DIESELS

AMERICAN LOCOMOTIVE COMPANY
SCHENECTADY, N. Y.

RELAYS AND SWITCHES

The K R A Series of Relays contain a one inch Bulls Eye indicating light and a terminal for connecting to an alarm bell or horn to give a signal when either a battery circuit is closed or where it is grounded. Time delays can be included for either making or breaking a circuit or both. Commonly used to give a warning in case of low oil pressure or high water temperature on engines.

The Model "G" Series of Switches are operated by a centrifugal governor that will open or close circuits at any desired R.P.M. They have an adjustment range of approximately 20% increase or decrease of the R.P.M. requested and can be manual or automatic reset type. The centrifugal operating unit can be direct connected or driven by gear-belt or chain, when used with our angle drive adapter.



The Model "C" Series is a heavy duty contactor for closing starting motor circuits or any other circuits from some remote control switch, either manual or automatic. This contactor is the same used in conjunction with our Automatic Controls for closing of the starting motor circuit. Contact capacity at 6 Volts D.C. inductive load — 1200 amp. inrush — 450 amp. cranking.

Pressure—Temperature and **Vacuum Switches.** These are used for Pilot Switches to open or close a circuit at predetermined values and are adjustable within certain ranges. They are sealed and of very rugged construction. Snap action switches are used which are operated by a sylphon bellows.

Tell us what you need!

SYNCHRO-START PRODUCTS, INC.

Automatic Engine Control Equipment

8151 NORTH RIDGEWAY AVENUE, SKOKIE, ILLINOIS

INTERESTED IN BURNING HEAVY FUEL?

De Laval Oil Purifiers Will Prepare the Oil for Combustion More Adequately than Any Other Means

De Laval Oil Purifiers are the most effective means in existence for preparing residual fuel for burning. These centrifuges remove a maximum amount of incombustible solids from heavy residual fuel.

The De Laval Oil Purifiers operate at constant efficiency. That means that the bowl removes dirt at a constant rate, from the moment it starts until it is completely full of dirt. Dirt is stored outside of the zone where purification takes place . . . the effective working bowl diameter is not decreased during operation.

In one specific instance, a De Laval bowl removed from 13 to 15 pounds of dirt in 5 hours before cleaning was necessary!

Write for the whole story . . .

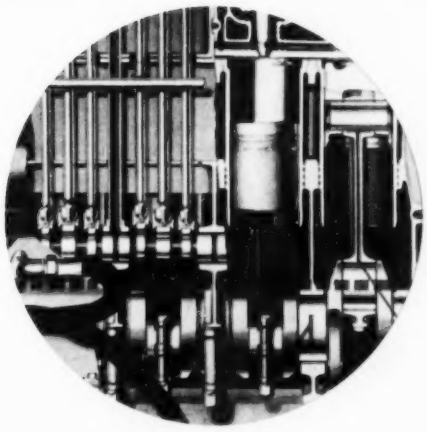
THE DE LAVAL SEPARATOR COMPANY
Chicago POUGHKEEPSIE, N.Y. San Francisco

De Laval

for most dependable power production

FUEL OIL PURIFIERS

Pure-sure used oil analysis

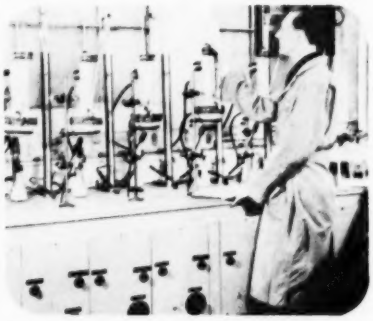


The best way to "look inside"

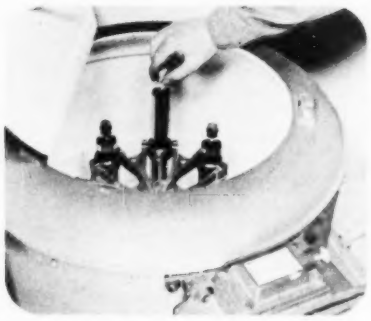
... to know what's going on inside your engine

THESE ARE THE STEPS THAT ARE TAKEN . . .

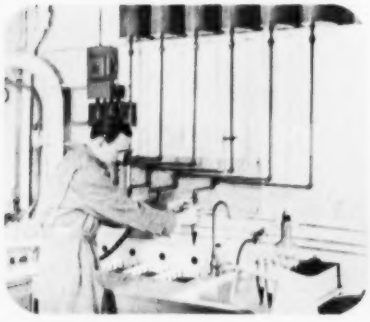
1. A sample of used motor oil from your engine is first heated to a standard temperature and its viscosity measured. Thickened oil may indicate oxidation or the presence of sludge. Thinned oil may be an indication of fuel dilution.



2. In this apparatus any fuel or water that may be present in your oil is "boiled off" and the quantity carefully measured. These percentages are recorded for comparison against known standards. Glycol tests are also made to detect hidden cooling system leaks.



3. After dilution with a solvent, solids are spun out of the used oil in this centrifuge. These are the contaminants which may result in harmful deposits or excessive engine wear. Carefully trained laboratory technicians conduct each test to assure accuracy.



4. Through the use of various chemicals many of these harmful materials can be identified. Those which can not be dissolved are examined under a powerful microscope for identification. By determining the types of solids present, their sources can be traced as an aid in diagnosis.

5. A tabulation of the results, together with all known information about the engine's operating conditions, is then reviewed by experienced automotive engineers. Each analysis receives a personal interpretation to determine what may be wrong, what causes it, and what to do about it.

HERE'S AN ACTUAL ANALYSIS . . .

ANALYSIS OF USED OIL

1. Viscosity of Used Oil		132
2. Used Oil SAE No.		30 Low
3. Fuel Dilution	%	5.0
4. Water in oil	%	0.0
5. Undispersed Solids	%	1.0
6. Dispersed Solids	%	0.5
7. Total Solids (5 & 6)	%	1.5

8. Tar and Asphaltic in 7	%	0.6
9. Gums in 7	%	0.6
10. Insolubles in 7	%	0.3
11. Metals in oil		Nil
12. Fuel Soot in oil		Slight
13. Free Carbon in oil		Slight
14. Dirt and Sand in oil		Nil

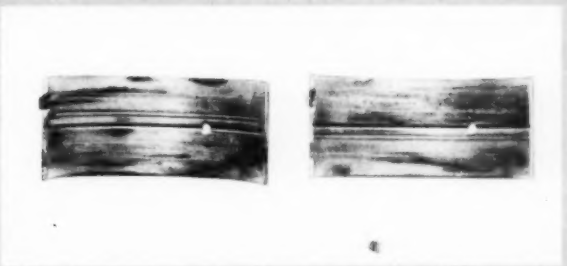
From these figures, Pure's automotive engineers were able to discover that the engine crankcase was not adequately ventilated. Corrective measures were recommended . . .

Results: Increase in safe oil drain intervals and elimination of varnish deposits.

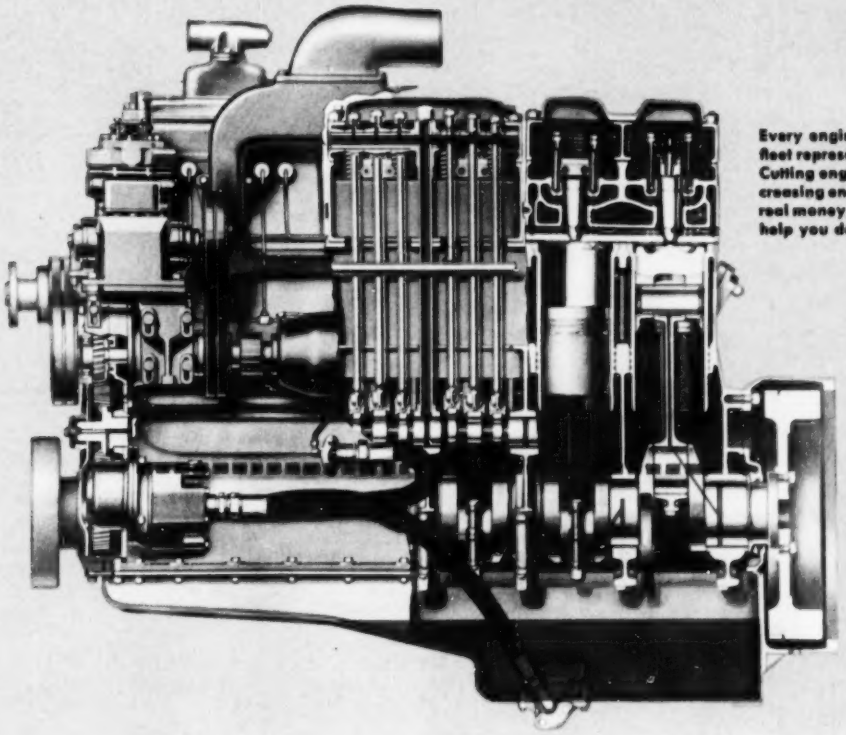
TO HELP YOU PREVENT DAMAGE LIKE THIS . . .

This piston failure was due to excessive corrosion, caused by low temperature operation.

This piston was damaged by a broken ring. Notice the large broken-out area. Excessivaly high temperatures or dirt can cause this type of failure.



Excessive dirt in oil is one of the items quickly detected by PS Analysis. Dirt in oil forms an effective grinding compound to wear away vital moving parts. Timely analysis of a 1-pint sample of oil might have prevented the deep grooving of these damaged bearings, as well as excessive wear of rings and cylinder walls.



Every engine in every unit of your fleet represents a major investment. Cutting engine maintenance and increasing engine efficiency both save real money. Pure-sure Analysis can help you do both.

AND HERE'S A TRUE SHORT-SHORT "DETECTIVE STORY"

. . . a typical example of the value in the free Pure Oil Service

On April 23rd a Pure-sure Analysis request came in with a sample of used oil. The operator complained of a "noisy engine."

Analysis revealed dangerously high fuel dilution, showed the viscosity of the oil reduced nearly to that of fuel oil!

On May 1st the Technical Service Department wired results, suggested: "Make immediate check for a broken fuel pump diaphragm."

On May 11th a field report confirmed that the analysis had located the trouble precisely! The fuel pump was fixed and a precious engine saved.

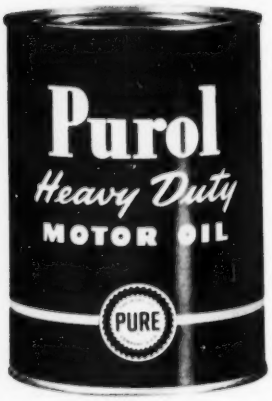
Get the facts about putting this valuable service to work in your maintenance department.* Ask your Pure Oil Representative or call or write your local Pure Oil office. Pure Oil offices are located in more than 500 principal cities, including: *Minneapolis . . . Madison . . . Detroit . . . Columbus . . . Memphis . . . Norfolk . . . Charlotte . . . Birmingham . . . Atlanta . . . Pensacola . . . Jacksonville . . . Miami . . . Toledo*

**This offer limited to fleet operators in Pure Oil's 24-state marketing area.*

(MAIL COUPON FOR FREE ANALYSIS OF YOUR USED OIL) ▶

and another way to PREVENT TROUBLE:

use top-quality PURE OIL PRODUCTS



PUROL H.D.

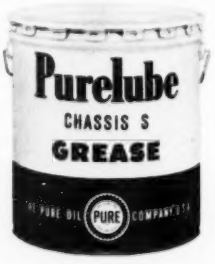
is called the "every duty" heavy duty motor oil . . . exceeds the rigid requirements of Military Specification Mil-0-2104. Contains precisely the correct amount of detergent and other additives needed to keep truck, bus, and car engines clean-running, smooth-running, *safe*.

PURELUBE MULTI-PURPOSE GEAR LUBRICANT

has such a high viscosity index that some grades meet the requirements of *two* SAE viscosity grades instead of one! Sure protection for heavily loaded differentials, transmissions, and steering gears. Non-foaming, non-corrosive.

PURELUBE CHASSIS GREASE

is a uniformly high-quality product designed to do the dual job of sealing dirt and moisture out while providing safe, solid-film lubrication. Provides a tough film between metal parts that won't rupture even under severe shock loads.



3166

The Pure Oil Company
Department DP-310
35 East Wacker Drive
Chicago 1, Illinois

Send me information on how I may obtain a Pure-sure Analysis of my used motor oil without cost or obligation.*

Name _____

Title _____

Company _____

Address _____

City _____ **State** _____

*This offer limited to fleet operators in Pure Oil's 24-state marketing area.

MAIL THIS COUPON TODAY!

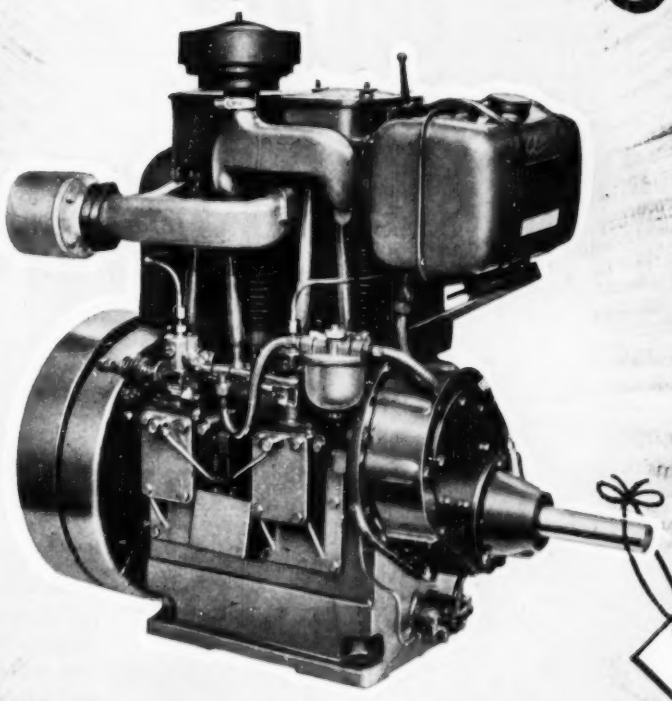
THE PURE OIL
PURE
COMPANY, U.S.A.

BE SURE WITH PURE

Petter

Diesel Engines

AIR-COOLED
WATER-COOLED
3 H.P. TO 40 H.P.



LOW COST

BACKED BY A WORLD-WIDE
PARTS AND SERVICE ORGANISATION
FOR THE 350,000 ENGINES IN USE

- MARINE AUXILIARIES
- GENERATORS
- PUMPING EQUIPMENT
- COMPRESSORS
- REFRIGERATION
- OIL FIELD EQUIPMENT
- MINING EQUIPMENT
- AGRICULTURAL MACHINERY

WRITE FOR INFORMATION

A FEW CHOICE DISTRIBUTORSHIPS OPEN

PETTER

ENGINE DIVISION OF BRUSH ABOE INC.

Office and Showroom 60-02 39th AVE. WOODSIDE, NEW YORK

How a railroad saved $3,000,000 a year

—and made its customers happier

These are actual figures taken from the records of one of America's leading railroads.

In 1946, when the first General Motors Diesel locomotive went on this line, costs of operating and maintaining steam locomotives totaled $9,600,000.

Four years later this road was completely dieselized. Traffic had increased. Costs had been reduced to $6,400,000—a saving of over $3,000,000 in one year's operation!

Business went up because, as everyone knows, trains headed by this modern motive power operate on swifter schedules, ride more smoothly and have a habit of arriving on time.

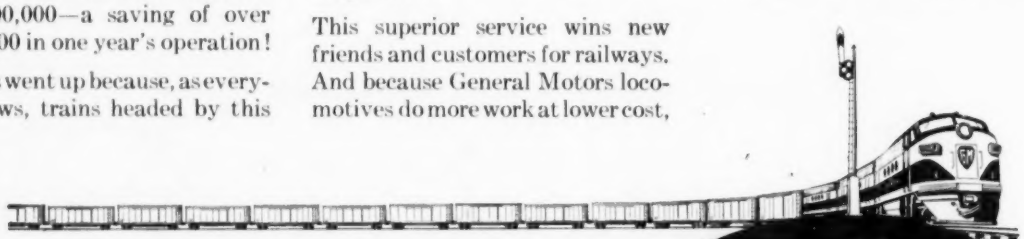
Shippers discover, too, that their goods are delivered more quickly and more dependably with less damage to lading, because of the Diesel's smoother operation, which travelers also appreciate on passenger trains.

This superior service wins new friends and customers for railways. And because General Motors locomotives do more work at lower cost, they pay for themselves rapidly—often in five years or less—contributing savings for the purchase of other new equipment needed by the railroads for better service.

Railroads cannot afford to delay—

COMPLETE DIESELIZATION WILL SAVE MILLIONS!

For full information, write for booklet, **"HOW COMPLETE DIESELIZATION PAYS OFF."**



ELECTRO-MOTIVE DIVISION
GENERAL MOTORS
LA GRANGE, ILLINOIS • HOME OF THE DIESEL LOCOMOTIVE

GENERAL MOTORS LOCOMOTIVES

IN CANADA: GENERAL MOTORS DIESEL, LTD., LONDON, ONTARIO

FAIRCHILD POWER for the RYAN FIREBEE

JET POWER to send a remote-controlled, high-altitude missile streaking across the sky at near-sonic speeds called for a new concept in powerplant design.

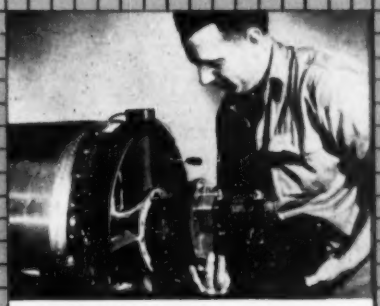
Fairchild met the challenge with the J-44 turbojet engine. It had to be extremely compact—yet provide more thrust than any engine of its size ever developed. It had to be expendable for warfare—yet quality-built for frequent re-use in research and training after parachute recovery.

In one application recently revealed, Fairchild's J-44 provides the power for the Firebee, a target drone with fighter plane performance, made by the Ryan Aeronautical Company.

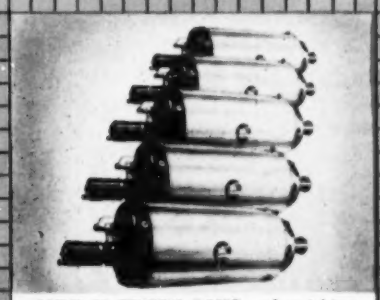
TIME WILL TELL of the expanding role in the nation's guided missiles program, in light aircraft and as a supplementary powerplant in large aircraft of this engine concept that *had to be different . . .* another example of the design, development and production facilities of Fairchild fulfilling specialized power requirements.

J-44 SPECIFICATIONS

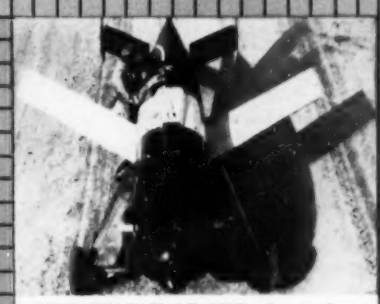
Announced thrust	*1000 lbs*
Weight	*300 lbs*
Length	*72 inches*
Diameter	*22 inches*



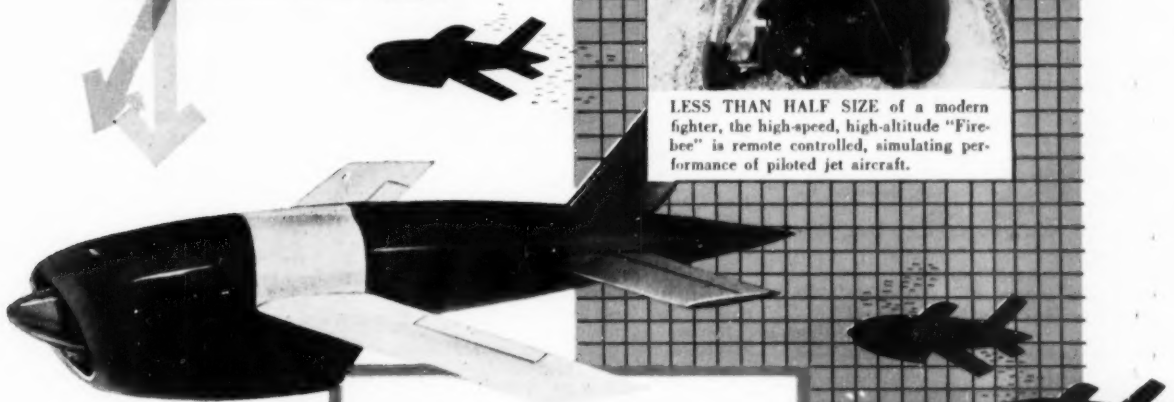
ACCESSORY SECTION containing essential controls, is quickly removed and replaced without special tools.



ONLY 72 INCHES LONG and weighing 300 pounds, the J-44 has varied applications in the nation's guided missiles program as well as in piloted aircraft.



LESS THAN HALF SIZE of a modern fighter, the high-speed, high-altitude "Firebee" is remote controlled, simulating performance of piloted jet aircraft.



ENGINE AND AIRPLANE CORPORATION

FAIRCHILD

Engine Division

Farmingdale, L.I., N.Y.

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Guided Missiles Division, Wyandanch, L.I., N.Y.

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San Francisco 3, Furrer & Uster, Inc., 225—7th St.
San Francisco 3, H. G. Makelim Magneto Repair Co., 1583 Howard Street
Wilmington, Diesel Control Corporation, 218 North Marine Ave.

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Miami 36, Florida Diesel Service Co., 1930 North Miami Ave.

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ILLINOIS

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Rock Island, Lohse Automotive Service, Inc., 430 North Capitol Ave.

INDIANA

Indianapolis, Gulling Auto Electric, Inc., 450 North Capital Ave.

IOWA

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Des Moines 9, Electrical Service & Sales Co., 1313 Walnut Street

KENTUCKY

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Mail Address: P.O. Box 661, Shreveport, La.

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MICHIGAN

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MINNESOTA

Minneapolis 6, Diesel Service Co., 2509 East Lake Street
Minneapolis 2, Reinhard Bros. Co., Inc., 11 South 9th Street

MISSOURI

Kansas City 8, Electrical & Magneto Service, Inc., 2538 Grand Avenue
St. Louis 23, Diesel Fuel Injection Service Co., 9331 South Broadway

NEBRASKA

Omaha 2, Carl A. Anderson, Inc., 16th and Jones St.

NEW JERSEY

Newark 2, Tire Trading Co., 239 Halsey Street

NEW YORK

Brooklyn 32, A&D Diesel Service, Inc., 145—21st St.
Brooklyn 16, E. A. Wildermuth, Inc., 1102 Atlantic Avenue
Buffalo 8, Hettrich Electric Service, 1032 Ellicott St.
Syracuse 4, F. A. Crossman, Inc., 943 Genesee St.
Troy, Ehrlich Electric Service, Inc., 200 Fourth St.

NORTH CAROLINA

Raleigh, Diesel Injection Service, 3015 Hillsboro Road

OHIO

Cleveland 14, Cleveland Ignition Co., 1301 Superior Ave., N. E.

OKLAHOMA

Tulsa 3, Magneto Ignition Co., 701 West 5th St.

OREGON

Portland 14, Automotive Products, Inc., 1700 Southeast Grand Ave.

PENNSYLVANIA

Hazelton, Penn Diesel Service Co., No. Church at 27th St.
Philadelphia 32, J. W. Parkin, Jr., 2251 North Broad Street
Pittsburgh 13, Automotive Ignition Co., 6358 Penn Avenue

TENNESSEE

Memphis 4, Automotive Electric Service Co., 982 Linden Ave.

TEXAS

Corpus Christi, Womack Bros., 1302 Caldwell
Dallas, Beard & Stone Electric Co., 3909 Live Oak Street
El Paso, Reynolds Battery & Magneto Co., 801 Myrtle Ave.
Houston 1, Beard & Stone Electric Co., Milam at Polk Street
Houston 11, Magneto & Diesel Injector Service, 6931 Navigation Blvd.
Odessa, Electric Service & Supply, 1601 North Grant Street
San Antonio, Womack Bros., 123 West Carolina

UTAH

Salt Lake City 2, Diesel Electric Service & Supply Co., 58 East 7th, South

VIRGINIA

Norfolk, Diesel Injection Sales & Service, 808 Union Street
Richmond 20, Charles H. Woodward Electric Co., 709 Broad Street
Salem, Diesel Injection Sales & Service, 814—8th Street

WASHINGTON

Seattle 1, Seattle Injector Co., 2706 Second Ave.
Seattle 14, Sunset Electric Co., 300 Westlake, North
Spokane 8, Sunset Electric Co., North 703 Division Street

WISCONSIN

Milwaukee 2, Wisconsin Magneto Co., 918 North Broadway

Canada

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Calgary, Hutton's, Ltd., 131—11th Avenue, West

BRITISH COLUMBIA

Vancouver, Magneto Sales & Service, Ltd., 126 Gore Avenue

NEWFOUNDLAND

St. John's, A. H. Murray & Co., Ltd.

QUEBEC

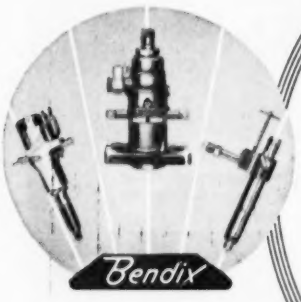
Montreal, International Electric Co., 1037 Bleury Street

Alaska

ALASKA, TERRITORY OF

Anchorage, Reeve Alaska Airmotive, Merrill Field, P.O. Box 1160

DIRECTORY OF SERVICE STATIONS IN U.S.A.



A NATION-WIDE *Authorized* SERVICE ORGANIZATION

Bendix

FUEL INJECTION EQUIPMENT

SCINTILLA MAGNETO DIVISION of Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

Western Office: 582 Market Street, San Francisco 4, California • Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N.Y.

Editorially Speaking . . . .

Thoughts on a Bad Brake

HUMM . . . Right wheel pulls. Have to fix it. Annoying. Dangerous. Have to get to the station; can't leave it; use it all week. Old car not worth it, anyway. Fix it Saturday. Use all those tools. Adjust; won't take a minute.

So Saturday comes . . .

Needs more than adjustment; can't get it right. Have to pull wheel. Uh-huh, cylinder piston stuck. Waddya expect on an old car? Fix that in no time. Cut block; drive out. Can't hone; use fine steel wool and solvent. That's got it; now put the rest back together. Not bad; little under an hour.

Better check hydraulic fluid reservoir. Needs fluid. Maybe get away without bleeding. See. Oh-oh. Look, Ma, no brakes! Better ease her back and bleed the lines.

Where do they bleed? Haffta scrape off an inch of dirt to see what the fitting looks like. Ah, that looks like the baby. What size wrench? Quarter-inch. Midget socket set will handle that. How do you like that? Not enough room for the socket and ratchet, and no ¼-in end wrench. Not much room for that either, and can't see. Wish the engineers had to work on this stuff. Might allow some room. Haffta mention that in an Editorial some day.

Well, pliers got that one out. Now get the wife to work the brake; see what happens. Nothing! Absolutely nothing! Must be plugged; try wire. Nope. Well, down it comes. Lunch? Already? Just got started.

Interlude . . .

Now it's apart. Let's see where it is plugged. What do you know! That's how it works, huh? Have to take out the first screw, then loosen the one that it screws into. How about that? Two-minute job, took two hours. Didn't know; didn't have manual. Wonder how fellows in the business, working on different makes and models over several years, could make out if they didn't have the right dope to start with. Important. Must put that in an Editorial some day.

Well, that's that. Got it all back together. Now to do that two-minute job. OK, that's bled. Adjust 'em now; get 'em even. Test fly it now. See if they work. Good, that's got it.

Let's see: took—WHAT? Four and a half hours!!! Figured at even three bucks an hour for mechanic's time and overhead that would be thirteen fifty. Boy, sure would hate to pay that for this job. Do it again in twenty minutes.

Let's see what took so long. Needed a certain tool. Ignition sets are about only thing with that size wrench. No room for a socket and had to feel; couldn't see. Looks like they forgot maintenance in that design. Didn't have the manual or specs. Auto man could get that stuff easily, but what about something on a diesel?

Should get that information into the hands of the people that need it, somehow. We'd print it. Sad case to have to take a thing all apart to find out how it works and guess on how to fix it. Could guess wrong. Often do. Bad thing—dissatisfaction and high maintenance costs. Won't do; kill business. Need more maintenance information, that's what.

Have to think about it. Some day, get it all together; stick it in an Editorial. Might do some good. Try, anyhow.

The oil with 3-way action that keeps railway Diesels clean

1 **Fights piston ring belt deposits (effective detergent action).**

2 **Resists sludging (high stability).**

3 **Prevents hard deposits on piston crowns (base stock quality and refining methods).**

GULF DIESELMOTIVE OIL

These are the reasons why Gulf Dieselmotive Oil protects against the accumulation of harmful deposits on compression and oil-control rings, on piston crowns, and in ports. Because engines lubricated with Gulf Dieselmotive Oil stay cleaner, they use less oil and require ring jobs less often. This means lower maintenance costs and less time off the road. For further information, write, wire, or phone your nearest Gulf office.

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GULF REFINING COMPANY
PITTSBURGH 30, PENNSYLVANIA

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+ HIGHLIGHTS +

● The National Diesel Engine Meeting of the SAE will be held at the Conrad Hilton Hotel, Chicago, Ill. The date—November 3 and 4, 1953.

● Esso "Oilways" tells us that there are almost 1400 companies engaged in petroleum transportation. This includes truck, railway, pipeline, and water transportation.

● Annual Meeting of the National Lubricating Grease Institute will be held at the Edgewater Beach Hotel in Chicago, Illinois from October 26 to 28 1953.

● AAR tells us that "diesel-electric locomotives performed 74 per cent of the passenger business and 82 per cent of the switching work on the railroads in April 1953.

● More than a million tons of crude oil and its products are moved through pipelines every day in the United States. But very few people, including those working in the oil and gas industry, have ever seen one of these lines, according to the API.

● America's first diesel-electric locomotive was a product of General Electric, American Locomotive, and Ingersoll-Rand. Almost 30 years have elapsed since the first of these units was put into service on the Long Island Railroad.

● During the first half of 1953, the FPC issued certificates authorizing the construction of facilities designed to bring the total of natural gas transmission facilities, for the 12-mo period ending June 30, 1953, up to 7123 miles of pipeline and 583,715 hp in compressor units.

● Technical developments valuable to metallurgists, engineers, chemists, and research workers, are described periodically in the Bibliography of Technical Reports published by the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Featured in a recent copy are studies in oil and gas.

● Over 8.3 million barrels of oil per day are required to met the United States' domestic and foreign demand.

● Switch engines on Indian and Burmese railroads are elephants who, according to EMD, have been doing this work for years.

● The American Society of Mechanical Engineers will hold its annual meeting at the Hotel Statler in New York City from November 29 to December 4, 1953.

● Receipt of a government contract in excess of $3½ million was recently announced by Roland Whitehurst, vice president of The Electric Storage Battery Co., manufacturer of Exide batteries.

● SAE's Fuels and Lubricants Meeting will be held November 4 to 6, 1953, at the Conrad Hilton Hotel in Chicago, Ill.

● The world's first railroad to employ microwaves—similar to the same waves that made coast-to-coast television possible—in the control of switches, signals and interlockings, runs from U. S. Steel's Cerro Bolivar mine to harbor facilities in Puerto Ordaz in Venezuela.

● Harvey Aluminum Inc., Torrence, Cal., recently filed an application with the FPC requesting a permit for a proposed hydro-electric project on the Copper River in Alaska. This is only one of numerous hydro-electric projects in the mill, all of which will require a lot of diesel horsepower-hours to build.

● Our nation's fire losses for the second consecutive year are at an all-time high—and this year threatens to exceed even 1952's peak of $815 million in property damage and 11,000 deaths, says the National Board of Fire Underwriters. Fire prevention should be thought of as a year-round job, not only thought of during Fire Prevention Week—which, incidentally, was October 4 to 10 this year.

● Chicago will be host to the SAE National Transportation Meeting from November 2 to 4, 1953. The meeting will be at the Conrad Hilton Hotel.

● It is estimated that by 1960, the United States will rely on oil and natural gas for about two-thirds of its energy, according to the API.

● Twenty years ago, a number of large buildings in New York City were being investigated with the idea of having diesels installed. Numerous engines were installed and today many of these are still in service.

● As of September 1, 1953, Class I railroads had 409 locomotive units on order as compared to 516 on August 1. On the same date last year, 1192 locomotive units were on order of which 1165 were diesel-electric units.

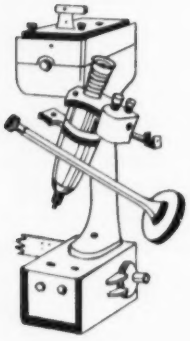
● Back in 1933, Cummins test-ran a diesel-powered bus from New York City to Los Angeles, Cal. Test results indicated a way to reduce operating costs as compared to gasoline engine operation—diesel power, of course.

● During the first eight months of 1953, Class I railroads installed 1565 locomotive units in service. Of the total, 1550 were diesel-electric units, 11 steam, and 4 gas turbine. In the same period of 1952, Class I railroads installed 2188 locomotive units.

● According to a recent news release, Caterpillar sold 40 Model D364 engines to an unidentified customer after the company ran a 5000-hr endurance test on two of its D364 engines. Both the name of the customer and the job to which the 40 engines were assigned were withheld for security reasons.

● The American Institute of Mining and Metallurgical Engineers and the American Society of Mechanical Engineers will hold their annual Joint Fuels Conference in the Grand Ballroom of the Conrad Hilton Hotel, Chicago, Ill., October 29 and 30, 1953. This will be the 16th such annual meeting.

GM Series "71" Engine Tune-Up



Step by step procedures for tuning up Series "71" 3, 4, and 6-cyl engines as recommended by the Detroit Diesel Engine Division of General Motors. Data for engines with three governor types is given.

ENGINE tune-up will, generally, improve the performance of the Series "71" engines. However, it should not be expected to correct deficiencies the cause of which lies in engine components not included in the tune-up procedure.

It will, for example, improve the timing of injectors but will not correct faulty internal mechanisms or take the place of an adequate supply of clean fuel oil. Similarly, it will insure proper exhaust valve clearances but will not compensate for fouled ports, leaky valves, or worn liners and piston rings.

Consequently, the success of a tune-up is predicated on the fact that the engine is in good mechanical condition and properly supplied with clean air, clean fuel oil and clean lubrication oil. Tune-up adjustments will then assure top performance. It is important that the steps to be outlined are followed carefully and in proper sequence.

Step 1—Adjusting Valve Clearance

1. With engine not running but at operating temperature, clearance between the valve rocker arm and exhaust valve stem should be maintained at .009 in. This is important. Too little clearance causes compression loss, misfiring, and eventual burning of valves and seats. Too much clearance causes noisy operation, particularly at low speeds.

2. Use feeler gauge set, 0.008-in "Go", 0.010-in "No-Go" (Service Tool KMO-233).

3. Set governor control level to no-fuel position to prevent accidental starting.

4. Rotate crankshaft clockwise using wrench on crankshaft cap retaining bolt, or turn with starter to position rocker arms for adjustment. Clearance should be measured when injector rocker arm has completely depressed the injector plunger for that particular cylinder.

5. Clearance adjustment (see Fig. 1) is made with a 5/16-in end wrench and a ½-in end wrench by loosening pushrod locknut (2) and turning pushrod (1).

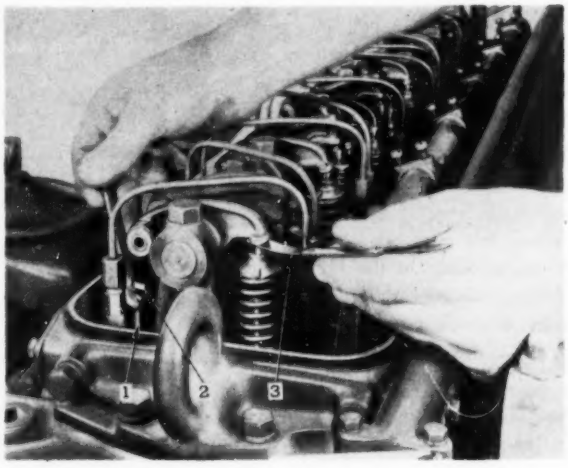


Fig. 1—Adjusting Valve Clearances
1. Pushrod
2. Pushrod locknut
3. Feeler gauge

6. Adjust pushrod with 0.010-in feeler gauge between rocker arm and valve stem to obtain a smooth "pull" of the feeler gauge (3). Remove gauge, hold pushrod from turning, and tighten locknut.

7. Recheck clearance. Now, 0.008-in "Go" feeler should enter clearance, but 0.010-in "No-Go" feeler should not.

8. Follow same procedure on all cylinders.

Caution: If pushrod has been disconnected from clevis, make sure that it is screwed back until the end of the rod appears through the clevis. If this is not done, while turning the engine over, the piston may hit the valve head due to the small clearance between the valves and piston head when the piston is in upper position. This also applies to injector pushrods. The injector may "bottom" before being properly adjusted.

Step 2—Timing Fuel Injectors

1. Injectors should be properly timed (see Fig. 2), using the proper Timing Gauge Tool for the particular injectors installed. Injectors may be identified by either the color of the tag pressed into the injector body or a letter stamped on the body. Identification is given below.

Injector Marking	Timing Gauge Tool No.	*Height
Blue Tag (60) or ("A")	J-1242	1.484"
Black Tag (70) (none)	J-1853	1.460"
Green Tag (80) or ("M")	J-1853	1.460"

**Timing gauge stem length from top of pilot to underside of head.*

2. Set governor control lever in no-fuel position.

3. Rotate crankshaft until the exhaust valve rocker arms of the particular cylinder being timed are almost fully depressed. Place pilot of timing gauge (5) in hole provided in injector body with one of the "flats" toward the injector.

4. Adjust rocker arm (7) by turning pushrod with 5/16-in end wrench until the bottom of the timing gauge head will just pass over (drag lightly) the top of the injector follower guide (4).

5. Hold pushrod and tighten locknut. Recheck the adjustment with the timing gauge.

6. Follow through on all cylinders.

Note: Steps 3 through 6 are given in triplicate, each pertaining to a specific type of governor. Full sequence of tune-up procedures for your particular setup can thus be followed.

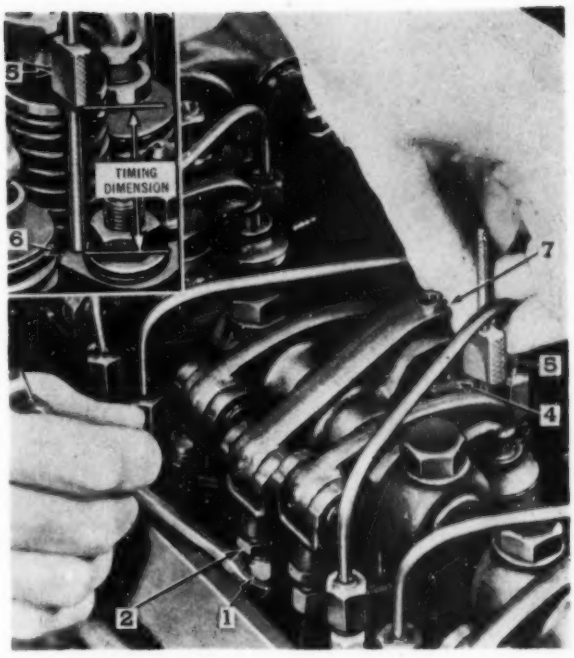


Fig. 2—Timing Fuel Injectors

1. *Pushrod*
2. *Pushrod locknut*
4. *Injector follower guide*
5. *Injector timing gauge*
6. *Injector body*
7. *Injector rocker arm*

Limiting Speed-Type Mechanical Governors

Step 3—Setting Governor Gap

1. For proper performance and full power, the governor must be properly set. Adjustment is made with the engine running. Refer to Fig. 3, except as indicated. Low-speed spring cap (10) must be correctly set in relation to the high-speed spring plunger (11) with space referred to as the "governor gap". Improper adjustment will result in a "flat spot" whereby the governor control lever (20, Fig. 5) can be moved toward full-fuel position without a corresponding change in engine speed. If the gap is too narrow, the flat spot will occur between 800-1200 rpm and if too wide, between 1200-1600 rpm.

2. Remove cover and set idle adjusting screw (3) to project three to four threads from the locknut (4).

3. Remove governor cover and governor-to-control tube link (22, Fig. 5).

4. Set the governor gap by either of the two following methods, taking care that the engine does not overspeed. *Remember that it is disconnected from the governor.*

Method A—Start engine and regulate speed by hand-operation of the control tube lever (8) to between 700-1000 rpm. Adjust the gap, using adjusting screw (9) to obtain 0.001-0.002-in clearance. This can be measured by a 0.0015-in feeler gauge between cap (10) and plunger (11).

Method B—(see Fig. 4)—Control engine speed as for

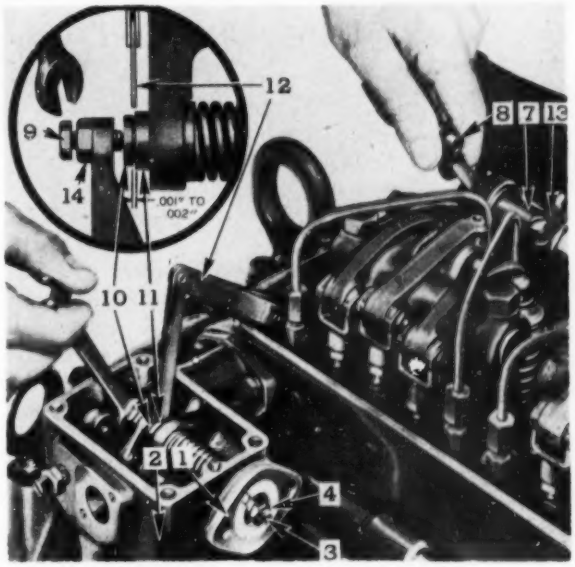
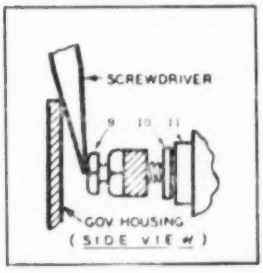


Fig. 3—Setting the Governor Gap

1. *Boss for cover*
2. *Governor housing*
3. *Idle adjusting screw*
4. *Idle adjusting screw locknut*
7. *Injector control tube*
8. *Control tube lever*
9. *Gap adjusting screw*
10. *Low speed spring cap*
11. *High speed spring plunger*
12. *Feeler gauge (0.0015")*
13. *Rack control lever*
14. *Gap adjusting screw locknut*

Fig. 4—Gap Setting (Method B)



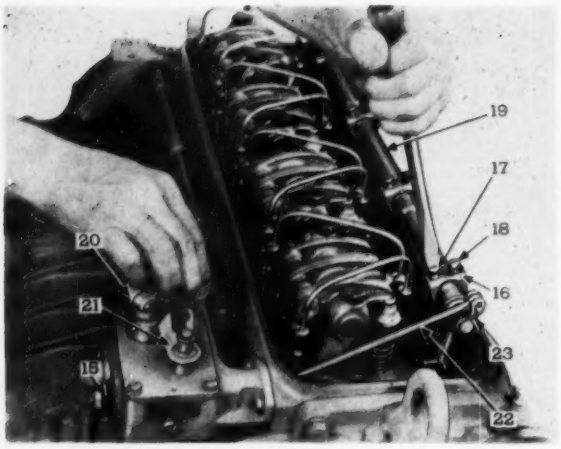


Fig. 5—Positioning Injector Racks

15. Buffer screw
16. Rack control lever
17. Inner adjusting screw
18. Outer adjusting screw
19. Injector control tube
20. Governor control lever
21. Governor control cam
22. Link-governor to control tube
23. Control tube lever

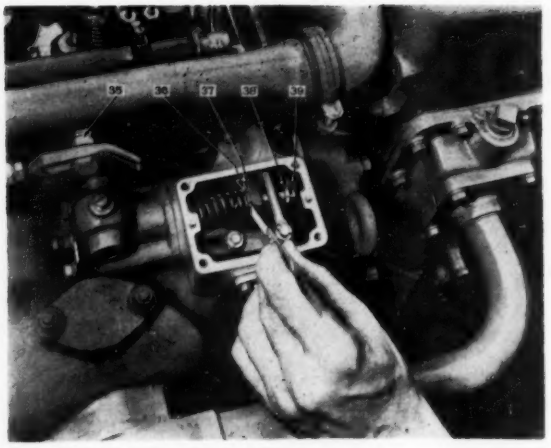


Fig. 6—Governor Spring Plunger Setting

35. Variable speed control lever
36. Spring plunger
37. Spring plunger guide
38. Screw locknut
39. Gap adjusting screw

Method A. Tighten adjusting screw until a 0.001-0.002-in gap had been obtained visually. Place a few drops of oil in governor gap. Pressure of screwdriver against the adjusting screw should produce a very slight movement of the cap toward the plunger, causing oil to be forced from the gap in the form of a small bead. Feeler gauge is unnecessary once skill in the use of this method has been acquired. Locknut (14, Fig. 3) must be tight when the gap setting is checked.

5. Stop engine and replace link and governor cover.

6. Whenever the gap setting has been changed, injector racks must be repositioned by adjustment of rack control levers.

Step 4—Positioning Rack Control Levers

1. Position of injector racks must be set in relation to the governor. Their position determines amount of fuel injected in each cylinder, and when properly set insures equal distribution of load. Refer to Fig. 5. No. 1 rack control lever (16) is adjusted first to establish a guide for the others.

2. Start adjustment by loosening locknut and backing out buffer screw (15) until it projects about 5/8-in from the governor housing.

3. Loosen inner (17) and outer (18) adjusting screws of all injector rack control levers (16) several turns, allowing them to swing freely on the control tube (19).

4. Turn down inner adjusting screw on No. 1 rack control lever until it just "bottoms".

5. Move governor control lever (20) toward full-open position, but do not force it past point where resistance to movement suddenly increases. Hold at this point, pressing lightly toward full-open position.

6. Back off inner adjusting screw, allowing control lever to move toward full-open position until it just "bottoms" at end of governor cam (21).

7. Tighten outer adjusting screw to lock rack control lever in position.

8. Check adjustment by holding governor control lever in full-open position and pulling injector control tube lever (23) toward governor. Movement should not exceed 1/64-in. maximum.

9. If movement is excessive, reset. *Once setting of No. 1 rack control lever is correct, do not change throughout adjustment of remaining rack control levers.*

Step 5—Adjusting Remaining Rack Control Levers

1. With governor control lever in full-open position, note rotary movement of No. 1 injector rack-to-lever coupling. Finger-tip pressure will produce a tendency to rotate, but coupling should not be loose. Other rack control levers must be adjusted to produce the same "feel" at couplings.

2. Set governor control lever in "idle notch" of governor control cam. Adjust No. 2 rack control lever by turning down inner adjusting screw while finger tip is touching the No. 2 injector rack coupling. When coupling loses its rotary movement, tighten outer adjusting screw.

3. "Feel" Nos. 2 and 1 to check rotary movement. If No. 1 now feel loose, No. 2 rack coupling is too tight. Correct No. 2 by loosening inner adjusting screw and tightening outer adjusting screw. If No. 2 feels loose, reverse the procedure.

4. Repeat the process for all of the rack control levers in each case comparing the "feel" with No. 1 rack coupling. *Remember, never alter No. 1 setting but match others to it.*

Step 6—Idle Speed Adjustment

1. Start engine and warm up to operating temperature.

2. Run engine with governor control lever against

idle notch. To remove "roll", gradually turn in buffer screw (15, Fig. 5) until roll nearly disappears.

3. Turn idle speed adjusting screw to obtain an average speed of about 300-500 rpm (speed recommended in operating manual). "In" increases speed and "out" decreases it.

4. Adjust buffer screw until idle "roll" just disappears. Do not raise idle speed more than 20 rpm with the buffer screw or it may interfere with stopping the engine.

Variable Speed Mechanical Governor

Step 3—Check Governor Spring Plunger Setting

1. With engine stopped, disconnect linkage to governor control lever (44, Fig. 7).

2. Now refer to Fig. 6. Secure variable speed control lever (35) in full-speed position (all the way back).

3. Measure the "governor gap" between the spring plunger (36) and spring plunger guide (37) with a 0.006-in feeler gauge. Specifications are from 0.005 to 0.007 in. If gap is correct, re-install governor cover.

3. To adjust, loosen the gap adjusting screw locknut (38) and turn the adjusting screw (39) in or out to obtain proper clearance. Always tighten locknut before checking gap setting. Re-install governor cover.

Step 4—Positioning Rack Control Levers

1. Refer to Fig. 7. Loosen locknut and back out buffer screw (46 and 47, Fig. 8) until it projects about 5/8-in from governor housing.

2. If load limit screw is used in place of screw (45), loosen locknut and screw out all the way.

3. Loosen inner and outer adjusting screws of all rack control levers approximately three full turns and be sure that all levers swing freely on the control tube.

4. Secure the variable speed control lever (35) in the full-speed position (all the way back) and place the governor control lever (44) in the "off" position. No. 1 rack control lever must be adjusted first to establish the proper relationship between governor and control tube.

5. Turn down inner adjusting screw on No. 1 rack control lever until it just "bottoms".

6. Move governor control lever (44) toward "run" position but do not force it past point where resistance to movement suddenly increases. Hold at this point, pressing lightly toward "run" position.

7. Back off inner adjusting screw allowing control lever to move toward "run" position until it just bottoms at the end of governor cam. Turn down outer adjusting screw until snug, but do not tighten. Tighten inner adjusting screw and then the outer adjusting screw. This should set No. 1 rack control lever.

8. Check setting. Governor control lever should travel to limit of the governor cam with no increase in resistance. When held in this position, light fingertip pressure should show the rack to be tight. If the governor control lever is not free to travel the full distance, the rack is too tight. Loosen the inner adjusting screw slightly, tighten the outer adjusting screw, and then the inner adjusting screw. This should do it. If the governor control lever is free to move its full distance and fingertip pressure causes the rack to rotate, the setting is too loose. Reverse the corrective procedure given. *After No. 1 rack control lever is set, it must not be changed throughout setting of the remaining rack control levers.*

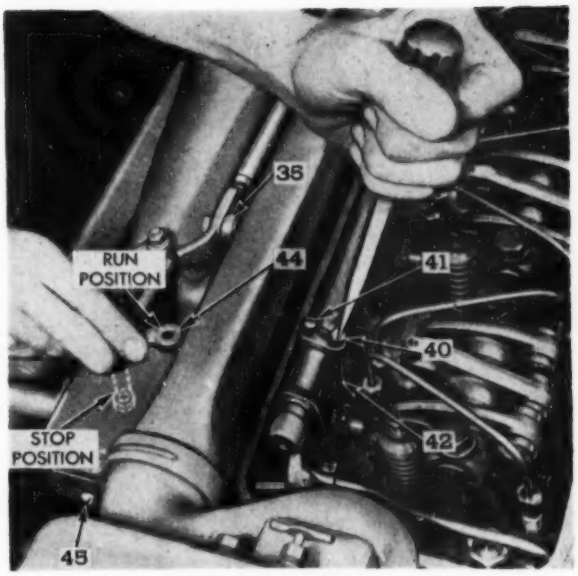


Fig. 7—Positioning Injector Rack Control Levers

35. *Variable speed control lever*
40. *Inner adjusting screw*
41. *Outer adjusting screw*
42. *Rack control lever*
44. *Governor fuel control lever*
45. *Screw (or load limit)*

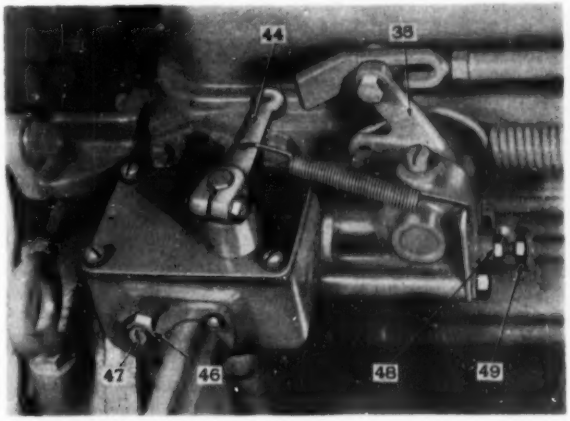


Fig. 8—Idle Speed Adjustment

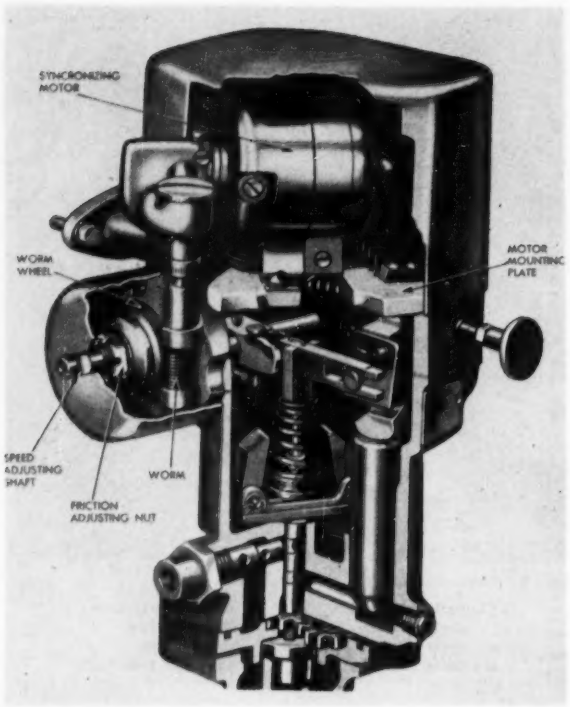
35. *Variable speed control lever*
44. *Govern fuel control lever*
46. *Buffer screw locknut*
47. *Buffer screw*
48. *Idle speed screw locknut*
49. *Idle speed screw*

Step 5—Adjusting Remaining Rack Control Levers

1. Adjustment of remaining rack control levers is performed by the "feel" comparison method as outlined in Step 5 for "Limiting Speed-Type Mechanical Governors".

Step 6—Idle Speed Adjustment

1. Refer to Fig. 8. Set governor control lever (44) in "run" position and variable speed control lever (35) in



Hydaulic governor with reversible electric synchronizing motor permitting close adjustment of engine speed by remote control at any load. Feature is excellent when synchronizing for parallel generator operation.

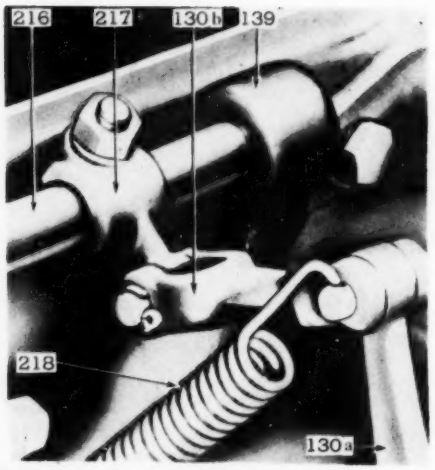


Fig. 9—Correct Throttle Linkage Position
130a. Governor operating lever
130b. Clevis link
139. Shaft attaching bracket
216. Throttle control shaft
217. Lever-shaft to throttle link
218. Return spring

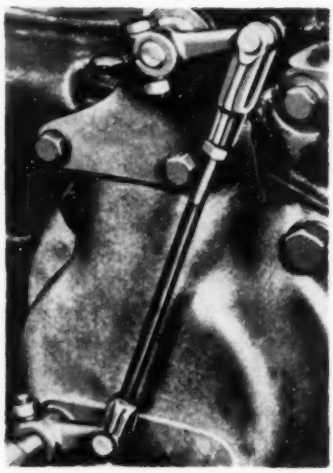


Fig. 10—Vertical Adjustable Link

at least half-speed position (slightly forward of vertical). This insures maximum fuel injection while cranking. Start and warm up the engine.

2. Disconnect linkage to variable speed control lever, if any, and move all the way forward to idle position.

3. If engine "rolls" excessively, turn in buffer screw (47) until roll nearly disappears.

4. Adjust idle speed by loosening idle speed screw locknut (48) and turning idle speed screw (49) in to increase speed and out to decrease it. Set idle speed 10-20 rpm below desired speed and tighten locknut..

5. If engine does not "roll", increase idle speed 10-20 rpm with buffer screw. If it does "roll", back out buffer screw until the roll becomes pronounced and then gradually turn in until the roll disappears. Do not increase idle speed by more than 20 rpm as it may interfere with stopping the engine. Tighten locknut. *Note: If a greater increase is necessary to get smooth idling, look for and correct binding in the governor, injector racks, or control tube.*

6. To recheck buffer screw setting, hand-operate variable speed control lever and observe movement of both injector racks and control tube. Accelerate and quickly return to idle. Rack control tube movement should cease after one or two surges.

7. If load-limit screw is used it should be set to give desired maximum output and locked in place. Procedure depends on application, but the idea is to let racks move toward full-fuel position just enough to develop the required power.

Hydraulic Governor Adjustment

First, don't change any settings unless adjustments are necessary. If adjustment is necessary, be sure that the engine is at operating temperature and then follow the sequences carefully. Start with the engine shut down.

Step 3—Linkage Check and Fuel Rod Adjustment

1. With throttle in full-fuel position, lever (217) and link (130b) are positioned as shown in Fig. 9. They must not turn into or above a dead-center position. Throttle shaft (216) is slotted to permit assembly of lever in approximately correct position. Some models provide further adjustment through a vertical adjustable link at the opposite end of the control shaft (Fig. 10).

2. Fuel rod (Fig. 11) should be adjusted to insure "no-fuel" and "full-fuel" position of injector racks. Start by disconnecting solonoid (if so equipped) and governor cover.

3. With fuel rod out in "stop" position, loosen adjusting screws in all rack control levers so that they all move freely.

4. Loosen fuel rod locknut (16) and remove knob.

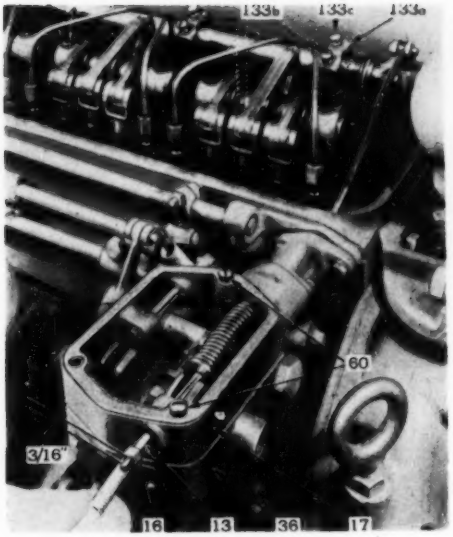


Fig. 11—Adjusting Fuel Rod
13. Fuel rod
16. Shut-Down knob locknut
17. Subcap
36. Governor case
60. Cover and subcap to screw case
133a. Rack control lever
133b. Inner adjusting screw
133c. Outer adjusting screw

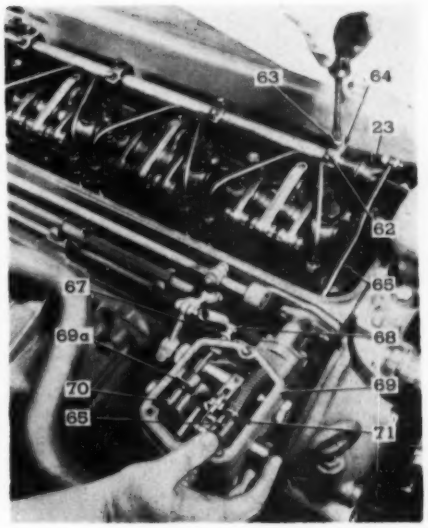


Fig. 12—Setting Terminal Lever for Wide-Open Throttle
23. Control tube lever
62. Inner adjusting screw
63. Outer adjusting screw
64. Rack control lever
65. Fuel rod
67. Max. fuel adjusting screw locknut
68. Max. fuel adjusting screw
69. Subcap
69a. Gover subcap boss
70. Terminal lever
71. Fuel rod collar

Turn locknut so that 3/16-in of the fuel rod (13) extends beyond nut. Replace knob against locknut and tighten the locknut.

Step 4—Adjusting No. 1 Injector Rack

1. Refer to Fig. 12. Loosen locknut (67) on maximum fuel-adjusting (load-limit) screw, and back screw out flush with outer face of boss (69a). Holding the fuel rod all the way in and the terminal lever (70) firmly against the boss (69a), turn down inner rack control lever, adjusting screw until fuel rod collar (71) contacts terminal lever and the terminal lever just starts to leave the boss. Tighten outer adjusting screw on No. 1 rack control lever.

Step 4a—Maximum Fuel Adjustment

1. Hold fuel rod in "full-fuel" position and terminal lever firmly against fuel rod collar (Fig. 13). *Caution: Excessive pressure on fuel rod after bottoming may cause rod to bend.*

2. Turn adjusting screw (64) in until a 0.020-in gap exists between the terminal lever (31) and collar (22). Tighten locknut (38). Clearance must not exceed 0.020-in as it would then be impossible to obtain full-fuel position of injector racks.

Step 4b—Positioning Remaining Injector Racks

1. See Fig. 14. Remove clevis pin to disconnect fuel rod between governor and control tube lever.

2. Move control tube lever (6) to hold No. 1 injector rack in full-fuel position and adjust No. 2 rack. Turn inner adjusting screw (133b) until injector rack is felt to "bottom". Tighten outer adjusting screw (133c).

3. Check Nos. 1 and 2 rack couplings with fingertip for rotary movement. If the "feel" is different, correct by readjusting No. 2 rack.

4. Repeat procedure, comparing remaining racks to No. 1 rack. When done, replace clevis pin to connect fuel rod to control tube lever. *Caution: Clevis pin must rotate freely. Binding will result in erratic governor operation.*

Step 5—Maximum Speed Adjustment

1. Initial setting is made to establish maximum speed and insure sufficient range for final speed droop adjustment. Start engine and thoroughly warm up. Check no-load speed on panel tachometer. Generator sets equipped with frequency meters may be checked by hand tachometer. In some models it is necessary to remove the ventilation panel and hold hand tachometer against rear end of generator armature shaft. Note nameplate data for full-load speed and ratings.

2. First, position droop bracket so adjusting screw (39, Fig. 16) is equal distance from both ends of slot.

3. On generator sets, adjust engine speed with vernier control or by switch controlling synchronizing motor to run at maximum no-load speed (100 rpm above rating shown on nameplate).

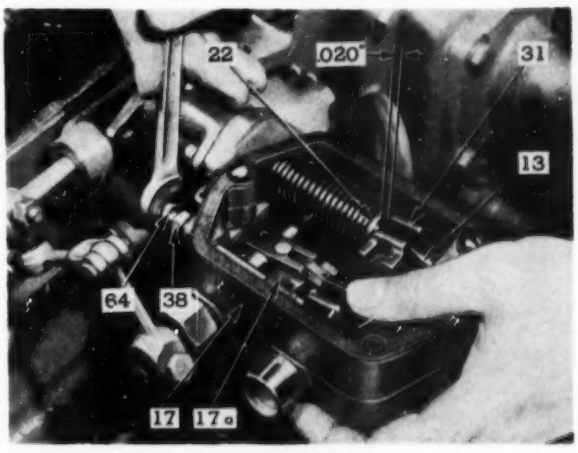


Fig. 13—Adjusting Maximum Fuel Screw
13. Fuel rod
17. Subcap
17a. Governor subcap boss
22. Collar on fuel rod
31. Terminal lever
32. Max. fuel adjusting screw locknut
64. Max. fuel adjusting screw

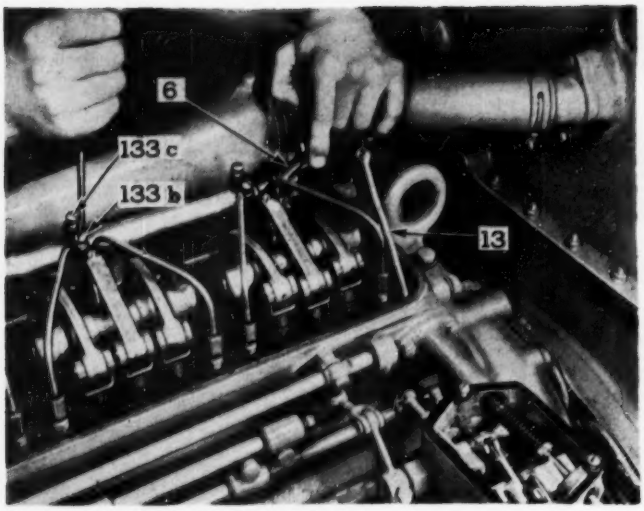


Fig. 14—Adjusting No. 2 Injector Rack
6. Control tube lever
13. Fuel rod
133b. Iner adjusting screw
133c. Outer adjusting screw

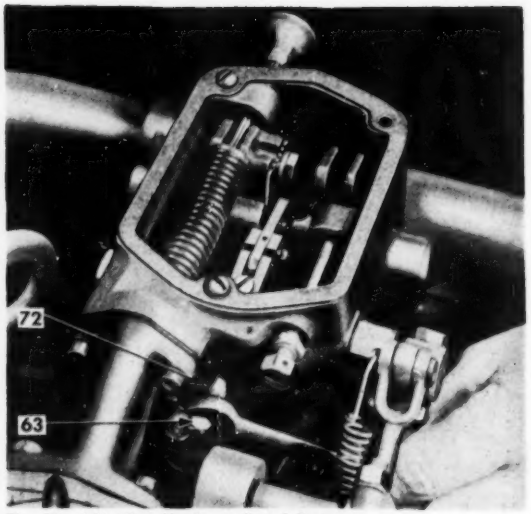


Fig. 15—Adjusting Maximum Speed Screw
63. High-speed limit adjusting screw
72. High-speed limit adjusting screw locknut

4. Loosen locknut on maximum speed adjusting screw (63, Fig. 15). Moving screw in will decrease and out will increase maximum speed. *Note: If necessary to decrease engine speed, first back off vernier control several turns before turning maximum speed adjusting screw in.*

Step 6—Speed Droop Adjustment

1. Adjustments are made with engine shut down. See Fig. 16. In applications where speed droop is not important, set droop bracket toward maximum droop position. If check reveals a droop of less than 40 or more than 60 rpm, stop the engine and adjust the speed droop.

2. Loosen droop bracket adjusting screw (39). Move bracket (32a) toward engine to decrease and away to increase the amount of droop. The bracket rides on a shoulder of the terminal lever (31). Hold bracket firmly in place on shoulder when tightening adjusting screw. If not so positioned, tightening of the adjusting screw will bend the bracket, resulting in erratic governor operation.

3. To check rpm on generator sets under no-load and full-load operation to determine droop, set vernier control to obtain ratings shown in the following table.

4. Adjust speed droop bracket to obtain the desired variation between no-load and full-load speeds shown in table. Standard speed droop is 50 rpm.

Full Load	No Load
50 cycles, 1000 rpm	52.5 cycles, 1050 rpm
60 cycles, 1200 rpm	62.5 cycles, 1250 rpm

5. Start engine and operate to check adjustments. *Note: Speed droop adjustment is external on earlier model governors. Speed droop in governors controlling engines driving generators in parellel must be identical to insure equally divided electrical load.*

The remaining Steps apply to the Series "71" engines irrespective of the type of governor used.

Step 7—Locating Misfiring Cylinder

1. With the valve cover off, start engine and set throttle at 1000 rpm. See Fig. 17.

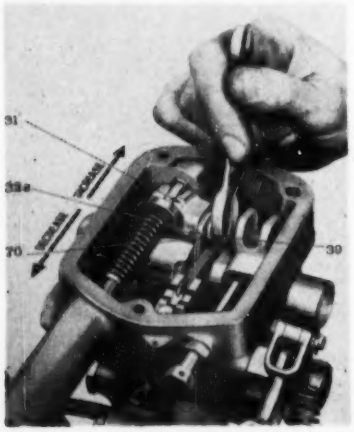


Fig. 16—Adjusting Speed Droop
31. Terminal lever
32a. Droop adjusting bracket
39. Droop adjusting screw
70. Droop adjusting screw washer

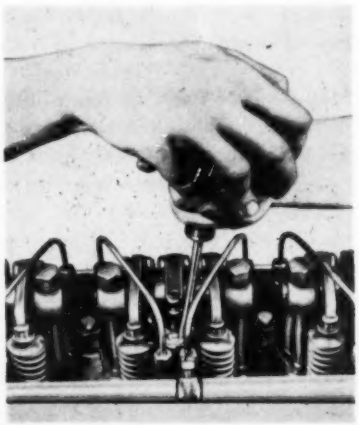


Fig. 17—Locating a misfiring cylinder by "hanging up" each injector in turn. Screwdriver is used to depress injector follower guide.

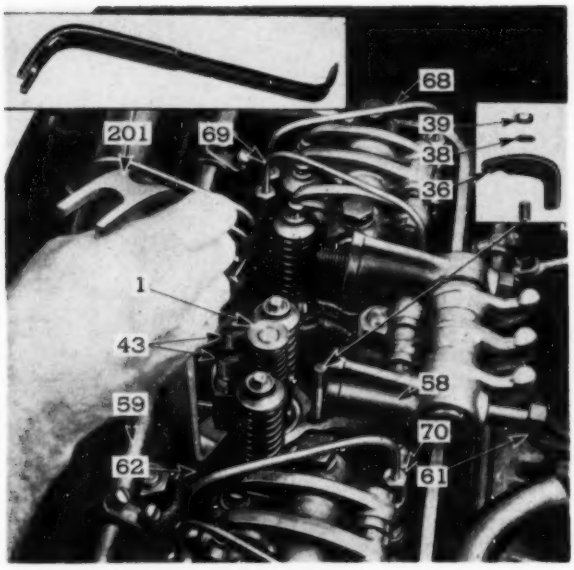


Fig. 18—Method of Injector Replacement

1. Injector assembly	*59. Injector control*
36. Clamp	*61. Bracket bolts*
38. Curved washer	*62. Cylinder head*
39. Injector holdown stud nut	*68. Fuel inlet pipe*
43. Shipping caps	*69. Fuel outlet pipe*
58. Rocker arm shaft brackets	*70. Fuel pipe connector*
201. Injector remover—Tool J 1227-A	

2. "Hang up" injectors one at a time by holding the injector follower guide (1) all the way down with a screwdriver. If the cylinder is OK, there will be a noticeable reduction in engine speed, difference in sound, and engine operation. No difference will be noted when you come to the bad cylinder.

3. Misfiring may be due to dirt under the spray tip valve and may be cured by flushing the injector. Set throttle in idle position. Back off on both rack control lever adjusting screws and move lever by hand into the full-fuel position. Maximum amount of fuel passing through the injector may flush out the dirt. *Do not allow detonation to continue for more than a few seconds.* If no detonation occurs, remove injector for inspection and take a compression reading on the cylinder.

4. Re-position rack control lever.

Step 8—Replacing Injectors

1. Refer to Fig. 18. To remove the injector, first remove the fuel jumper lines. Turn the engine until rocker arm clevises are even. Loosen the two rocker arm shaft bracket bolts (61) and fold entire assembly back from the valves and the injector.

2. Remove hold-down stud nut (39), curved washer (38), and clamp (36).

3. Using Service Tool No. J-1227 (201), loosen injector from seat and remove.

Caution: If new injector is not to be installed immediately, stuff clean lint-free cloth into injector tube to prevent dirt from entering cylinder.

4. To install injector, reverse sequence of above operations. Injector rack coupling must engage ballpin of injector rack lever. Line up injector body dowel with hole in cylinder head.

5. Place curved washer over stud with convex face next to clamp and tighten injector clamp nut to torque of 20-25 ft lb. Check injector rack for free operation with follower guide depressed as well as in upper position.

6. Replace rocker arm shaft bracket assembly. Check valve clearance and injector timing. Position injector rack control lever.

Note: Before installing rocker cover, start engine and inspect all fuel connections for leaks. Leaking fuel at the cylinder head can flow through the lube oil return passages directly into the crankcase, diluting the lube oil.

What Do You Know!

Here are some questions to test your general knowledge of the diesel field. Make your selections, then turn to Page 94 to check them.

1. The International Harvestor fuel injection pump has either one or two plunger units incorporating both a check and reverse check valve: Function of the reverse check valve is:
   a. To work in case check valve fails
   b. To relieve pressure in the line at end of injection
   c. To control maximum injection pressure developed

2. The fuel return check valve is another valve in the I-H plunger unit. Its function is to:
   a. Serve as a bypass for the primary pump
   b. Help lubricate the scavenging pump
   c. Maintain constant pressure in the fuel supply

3. Modern flexible hoses are so designed that there is little practical limit on their flexibility and they will accommodate appreciable motion in any direction.
   a. True b. False

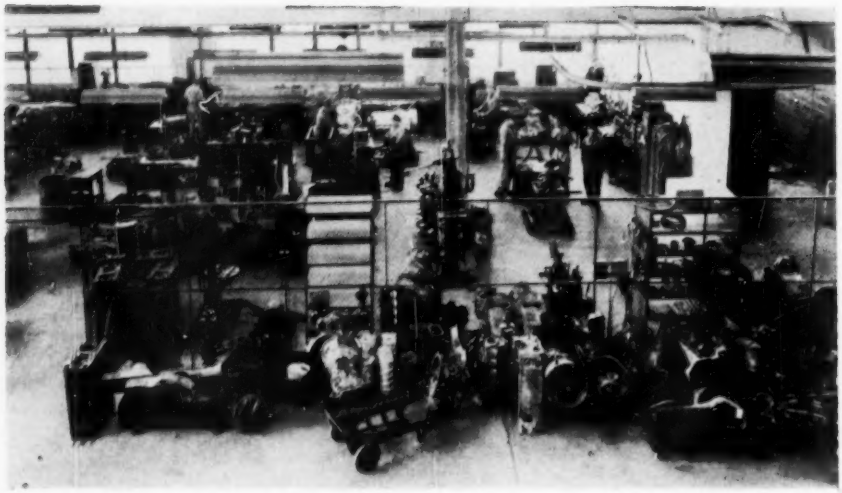
4. By means of design, construction, selection of materials, reinforcing braids, etc., flexible hoses can be obtained not only to withstand high flow pressures, but to provide some support to connected componets.
   a. True b. False

5. Sequence of operations during an engine tune-up is important and should be carefully followed because:
   a. The manufacturer has worked it out to save labor
   b. The earlier steps may affect later adjustments
   c. A set pattern will insure that no steps are missed

6. Governors on engines in parallel generator operations should be adjusted to have the speed droop because:
   a. They will then divide the electrical load better
   b. They run better that way
   c. They would lose synchronization

7. Although there may be different specifications, all injection nozzles are tested in the same way.
   a. True b. False

8. The ability of a nozzle to "pop" or "chatter" under test is not necessarily indicative of a good nozzle.
   a. True b. False



At left, is the engine rebuilding section of the Green Bus Lines' shop. When engines are disassembled, parts go to the cleaning stall at right.

Shop floors must also be kept clean. Safety as well as cleanliness must be thought of.

Cleaning —

A Part Of Maintenance

A good cleaning program should be an integral part of your overall maintenance set-up. Here is how one bus fleet is saving on maintenance costs with a thorough cleaning program.

ENGINES and equipment must be well lubricated if they are to operate smoothly and fulfilt a normal vehicle life expectancy. In a crankcase or transmission, a lubricant performs an essential function. But on a shop floor or coating a part in need of repairs, the same lubricant is out of place and assumes the role of dirt. As such, it must be removed.

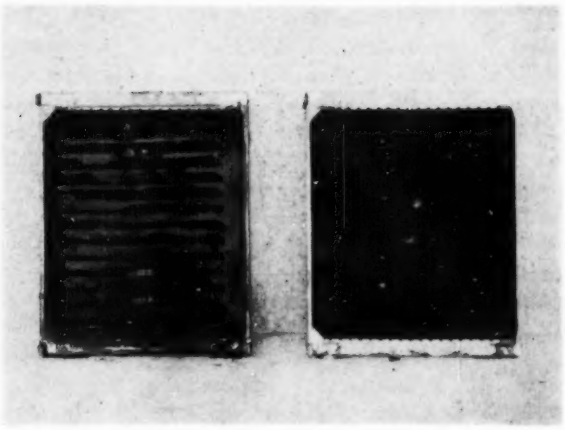
Removal of oil and grease in their unproductive form of soil is important for three reasons. First, a clean shop usually looks competent and is an incentive to those who work there to perform in a neat and orderly fashion and to handle their equipment the same way. Second, parts that have been well cleaned are easier to work on, permitting rapid, accurate inspection and first rate repair. Last but by no means least, oil and grease on shop floors are a menace to safety.

Appreciating that cleaning is an important part of maintenance, the next consideration is how best to deal with oil and grease when they become soil. The same characteristics that make them (oil and grease) good lubricants also make them tough soils. That is why planned cleaning is particularly important in the vehicle service field. Fleet service shops, ever on the alert to cut maintenance costs, have been quick to realize that planning their cleaning with outside help not only results in a cleaner shop and parts, but also is the most economical procedure in the long run—which is what any efficient service shop considers.

The modern bus fleet shop at which these photos were taken is one that has a planned cleaning program. As a result, the cleaning setup is as modern and effective as the building that houses it. Based on the anticipated needs of the shop, it was worked out with the aid of a qualified cleaning specialist, while the new building to house the maintenance facilities was still under construction.

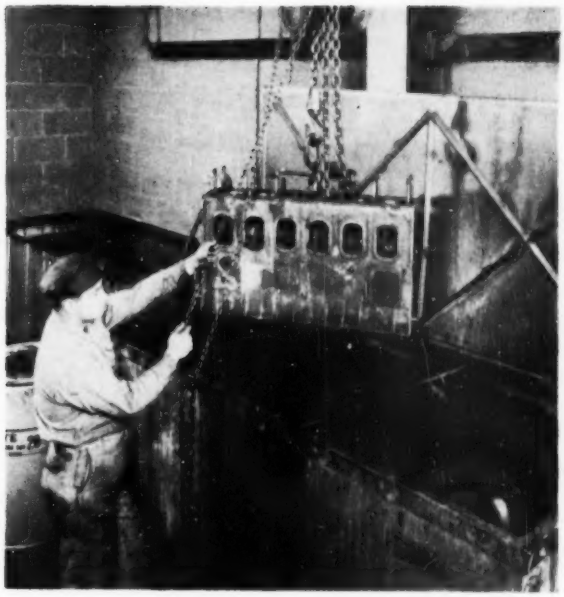
Buses maintained in this shop serve mushrooming communities on Long Island. During commuter hours particularly, the service is taxed to the utmost, making it essential that all available equipment be utilized. Thus, all repair and maintenance work must be handled with as little waste motion as possible to get buses back in service with a minimum of delay. The parts cleaning proceedure

* *Abstract of an article published in Oakite News Service by Oakite Products, Inc., New York, N. Y.*



Illustrated above are what might be called "before" and "after". The radiator core at left is badly clogged with road dirt while the core at right has been thoroughly cleaned prior to inspection.

At right, are the "hot-dip" tanks where parts are cleaned prior to inspection and reassembly or reconditioning.



was set up with this in mind. They rely on "hot tanks", charged with a solution of an Oakite alkaline detergent and gas-fired. Tank solutions are generally in the neighborhood of 180°F.

Grease-laden parts to be inspected and repaired go into tanks to soak while personnel keep busy at other tasks. Specialized grease-removing detergent, Oakite Composition No. 20, effectively removes soil deposits permitting removal of work, now thoroughly clean, in about 30 minutes. In addition to this composition, which handles cleaning of parts and radiators in the shop, Oakite Penetrant is used for keeping floors in good shape. The detergency of this specialized floor cleaner makes it effective at fairly dilute concentrations. Thus, keeping floors so clean, the shop resembles a laboratory more than it does a maintenance shop, and the operation is comparatively irexpensive.

While the hot tank used so successfully by this Long Island bus shop is a highly efficient means of cleaning parts, it is not the only way. Those smaller auto maintenance shops seeking to emulate methods used by fleet shops, but which lack heat, have an alternate parts cleaning method, also very effective, open to them. It depends upon the use of solvent-type grease-removing detergents used at room temperature.

Heat, or the lack of it, is only one of many considerations when setting up a cleaning procedure for a vehicle maintenance shop. In addition, the nature of the metal parts that go into the tank is important. Where iron, steel, aluminum and aluminum alloys are all going into the same hot tank, an alkaline detergent safe on the softest of these must be used.

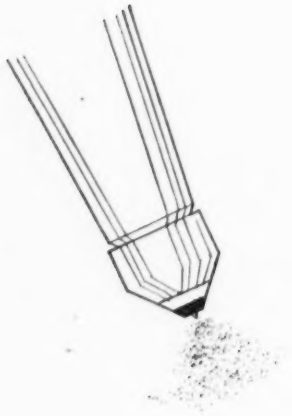
The best way for maintenance men with little experience in industrial cleaning to resolve problems (including those concerning costs) related to the cleaning end of their business is to follow the example of the fleet shop

Fleet maintenance man and Oakite Technical Service Representative discuss the planned cleaning program while inspecting a radiator core.

described here, and get help from a cleaning expert.

The technical service representative who helped set up the cleaning program for this fleet shop is typical of other Oakite service men around the country who work closely not only with operators of fleet shops, but with smaller shops as well. The advice they give about cleaning materials, methods, solution temperatures, tanks, heating elements, etc., is given free of charge and obligation.

In summarizing it might be well to point out that although written with a bus fleet in mind, the principles apply across the board. Regardless of the engine or equipment maintained, an integrated cleaning and preventive maintenance program will be of definite advantage both from a safety and economic standpoint.



Maintaining Fuel Injection Nozzles

Compiled By The Engineering Staff, Bacharach Industrial Instrument Co.

This comprehensive roundup of background data, testing and maintenance procedures, preferred general practices, and necessary tooling, will help you get the most out of your engine by keeping your nozzles in good condition.

YEARS ago, the diesel engine was looked upon as some big lumbering prime mover not too far removed from the old steam engine. We still see some pretty big babies today, but even so they have been greatly reduced in weight-horsepower ratio. Now, also without looking too far, we find that the diesel has invaded the small engine field. With this high-speed automotive diesel engine came specialized maintenance problems which had no parallel in the well-established spark ignition engine.

From a purely mechanical viewpoint, the principal difference between these two engine types lies in the substitution of a diesel fuel injection system for the electrical ignition system and carburetion system of the gasoline engine. Compression ignition is used in the diesel engine and the fuel injection system takes over the timing function of the ignition system, plus the functions of the carburetion system. It is the fuel injection system, then, that will present the major new maintenance problem to the uninitiated.

Two distinct units comprise a diesel fuel injection system. Quantity control is accomplished by means of a pump which injects the proper quantity of fuel demanded by a particular load setting at the proper time and at the desired rate to control combustion. Quality control is performed by the nozzle which atomizes the fuel, distributes it throughout the combustion chamber, and in such a manner that injection begins and ends sharply.

The latter unit, *i.e.*, the nozzle, will be the topic of discussion here, with emphasis on the maintenance of injection nozzles of high-speed automotive diesel engines. However, before plunging too deeply into service, perhaps it would be worthwhile to have a look at the different types of nozzles used in these diesel engines.

Nozzle Characteristics

A nozzle should deliver the metered fuel to the combustion chamber in such form that burning will begin easily and proceed rapidly, and in orderly fashion. In order to attain this, the fuel must be broken up into droplets such that the greatest number is less than about 0.0002-in diameter. This is accomplished by injecting the fuel through one or more orifices, or similar openings, at high pressures.

Upward of 1000-psi injection pressure is required to do this depending on orifice size, shape, fuel rate, and penetration desired. Proper control of the combustion process also requires that the nozzle has a snap action in opening and closing. It is desirable that the instant of injection be consistent and sharp. Similarly, injection must stop sharply with no fuel leaking into the combustion chamber following the cut-off.

Classification

Nozzles will first be categorized with respect to the type of valving used to cut off flow, prevent dribble, and block entry of compression and combustion gases into the nozzle. The first type will be called "open" for want of a more descriptive word. They are open in the sense that the check valves in the flow path are generally only lightly spring-loaded.

The closest approach to the true open type in use today is the Cummins nozzle (Fig.1). The Cummins system is unique in that it is desired that the hot compression air enter the nozzle and mix with the fuel prior to the time that the mechanically actuated plunger pressurizes and injects the fuel. A check valve is incorporated in the inlet passage to prevent the pressurized air from forcing a back-flow into the distributor and low-pressure metering pump.

The second type is the "closed" nozzle (Figs. 2a and 2b). Fuel from the pump is brought to a chamber surrounding the valve. When sufficient pressure builds up within the chamber to overcome a predetermined spring force, the valve will lift and allow the full pump pressure to be exerted against the orifice.

We may further classify nozzles as either the orifice

nozzle (Fig. 2a) or the pintle nozzle (Fig. 2b). The former may have one or more orifices placed either symmetrically or non-symmetrically around the tip, depending on the shape and size of the combustion chamber. The pintle nozzle discharges fuel from an annular ring formed by the extended tip of the plunger valve and the nozzle body. They may have either the throttling or non-throttling pintle. Fig. 2b is of the non-throttling variety. The throttling type is identified by the conical-shaped pintle.

Still another breakdown of nozzles may be made. This classification deals with the method of motivating the valves. If the pressure is acting directly on the bottom of the valve, as in the case of open nozzles, it is known as a direct hydraulically-actuated valve. On the other hand if the fuel is brought into a pressure gallery around the upper side of the valve such that the pressure must act on the annular area between the outside diameter of the valve (which may be the OD of the valve plunger) and the OD of the valve seat, it is known as the differential hydraulically-actuated valve (Figs. 2a and 2b). This type of valve requires a higher valve opening pressure than closing pressure because of the additional area of the valve subjected to delivery pressure after the valve is opened.

Thus we have six classifications which may describe a particular diesel nozzle. To review, they are: (1) the so-called open-type nozzle; (2) closed-type nozzle; (3) orifice nozzle; (4) pintle nozzle; (5) direct hydraulically-actuated valve; (6) differential hydraulically-actuated valve. Note that (4) and (6) will probably always be of the closed type and that when speaking of a nozzle, the various other parts which are necessary to the functioning of the nozzle are included (Fig. 3).

At this point mention should be made of Cummins' mechanically-operated nozzle and unit injectors. Actuation takes place at the injector unit by means of a cam, pushrod, and rocker arm mechanism. Mention has been made of the Cummins system wherein fuel at low pressure is delivered to the nozzle cavity and injected under pressure by plunger action.

Unit injectors such as the General Motors (Fig. 4) and Murphy units combine the metering and pressure pump, the nozzle, and nozzle holder into one package. While the unit injectors and the Cummins injector must be considered and tested as complete assemblies, the nozzle portions may be classified, under the criteria mentioned, as being of the open type.

Nozzle Ailments

Dirt, heat, water, and fuel acids are the biggest bugaboos to diesel injection nozzles. Breakage is rare. Spring relaxation or maladjustment frequently cause trouble.

Few mechanisms are built with the precision of diesel injection nozzles and subjected to such fierce punishment. High pressures, up to 10,000 psi depending on nozzle type, etc., make it mandatory that all parts sealing off the fuel fit perfectly. Clearances between valve stem and guide of closed nozzles are on the order of 0.0001-in

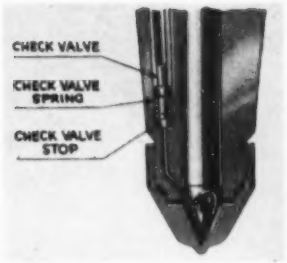
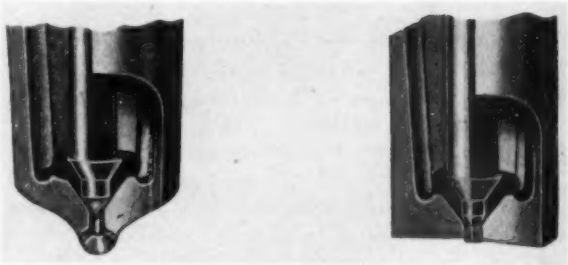


Fig. 1 Open type injector



(A) Orifice Type *(B) Pintle Type*

Fig. 2 Closed type differential hydraulically operated nozzles.

and concentricity tolerances between valve stems and valves, and consequently valve guides and seats, are of even smaller magnitude. Working surfaces are lapped to a high degree of surface smoothness.

Dirt therefore can play havoc with these surfaces. When we speak of dirt, we mean particles on the order of 5-microns size (0.0002-in). Speaking of what we have considered as open-type nozzles, dirt can clog or erode the orifices. Clogging causes high injection pressures and distorted spray patterns. Erosion causes injection pressures to fall off and also distorts spray pattern, adversely affecting fuel distribution.

Any check valves involved are also subject to dirt and erosion. Dirt may lodge on the valve surface, and the result of this, as well as erosion, will be leakage or fuel dribble between injection periods. Fuel will be wasted and smoky and incomplete combustion will occur, leading to carbon deposits on the nozzle and in the combustion chambers. Carbon deposits or craters on nozzle tips will deform the spray.

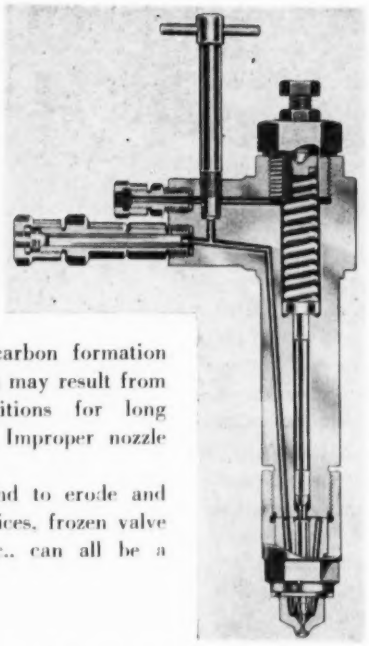
All closed-type nozzles are subject to the above dirt effects, but to a greater extent. With this type of nozzle, dirt may wedge itself between the valve stem and guide and impair motion or cause the valve to freeze, in which case injection timing and control will be completely lost. Leaking, and therefore the previously mentioned results from dribble, will also follow.

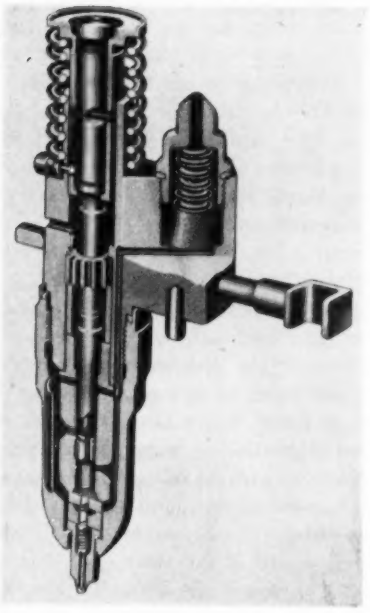
Should dirt imbed itself between valve stem and guide but not be of a serious enough nature to immediately cause sticking valves, it may score the finely lapped surfaces. Excessive fuel leakage past the valve stem and back to the fuel leak-off line will follow, which may cause rough engine operation and loss of power.

Heat indirectly has much the same effect as dirt on most nozzles since the fuel tends to breakdown and form hard carbon deposits on moving parts and openings.

Fig 3 At right, a typical nozzle holder with nozzzle is illustrated.

Fig. 4 Shown at far right is a cutaway of the GM unit injector.





Valve sticking, poor seating, dribble, carbon formation on nozzle tips—all these and their effects may result from overheating. Overloaded engine conditions for long periods can cause nozzles to overheat. Improper nozzle cooling will also lead to trouble.

Water in the fuel and fuel acids tend to erode and corrode the various parts. Enlarged orifices, frozen valve stems, deterioration of valve seats, etc., can all be a result of water or fuel acid.

Prevention of Nozzle Failures

Certain measures, some implied under the previous heading, should be observed to assure protection against those three common troubles: dirt, heat, and water. To summarize, they are: (1) Use only highgrade clean fuel. Before using the fuel it would be well to filter and centrifuge it. (2) Maintain filtering system between the fuel tank and the injection pump in perfect condition at all times. (3) Drain water from filters and strainers at regular intervals. (4) Guard against prolonged periods of overloaded engine operation. (5) Avoid excessive cooling water temperatures.

Effects of Nozzle Failures

Loss of power and rough operation are the two most serious effects of faulty nozzles. If either of these two conditions is due to a faulty nozzle, it is possible to locate the offending unit by cutting off the fuel delivery to each in turn. This is done by opening the bypass valve on nozzles so equipped or loosening the high-pressure fuel delivery line. With unit injectors, it is necessary to "hang up" the pumping mechanism. When the isolation of a nozzle produces no apparent change in power or roughness, chances are that it is the offending unit.

Heavy exhaust smoke with the engine under normal load may also be caused by a bad nozzle. The method of nozzle isolation may again be used. Bypassing the fuel with subsequent clearing of the exhaust smoke may pinpoint the defective nozzle. Note that dribble from a nozzle may cause heavy smoke, but may not be of serious enough nature to cause appreciable loss in power or undue engine roughness.

Combustion knock is another effect of a defective nozzle. However, tracing the knock to a particular cylinder is usually difficult. Too low a grade fuel may really be causing the knock.

Unusual exhaust temperatures either on the high or the low side may point toward a defective nozzle. However, most smaller engines are not as yet provided with exhaust pyrometers.

If any of the above troubles develop while an engine is in service, it is ultimately headed for an unscheduled shutdown. Therefore preventive maintenance is vital and nozzle testing is one of the most important steps of a maintenance program.

Nozzle Testing

Since proper injection of fuel is of foremost importance to satisfactory diesel performance, nozzles must be tested and tested often. General practice is to remove the nozzle from the engine and bench-test it. A typical test bench installation is shown in Fig. 5.

However, because of the close relationship between the fuel injection system and other engine factors, some engine builders recommend testing of the nozzles in the engine as a shortcut in pinpointing causes of poor engine performance. For such engine tests, the nozzle test pump is preferably mounted on a special bracket designed for convenient attachment to the particular engine to be tested. Fig. 6 shows this type of application on an International Harvester Model TD18A engine. This method of checking IH fuel systems, recommended by the engine builder, is unique in that all tests can be performed without removing the nozzle or the fuel pump from the engine.

Since maintenance shops are usually confronted with the need for servicing many different makes of diesel engines using widely varying types of fuel injection systems, manufacturers of nozzle testing equipment have devoted much effort and ingenuity to provide nozzle testing equipment designed for "universal" application.

The "universal" nozzle and injector tester shown in Fig. 7 is a typical example. By making use of specially engineered fixtures and fittings this unit handles American Bosch R, S, and T size nozzles, Bendix-Scintilla B and C size nozzles, Caterpillar nozzles, International Harvester nozzles, GM "71" and "110" injectors, and Cummins A, H, and NH injectors. The change from one type of nozzle or injector to another type is accomplished swiftly by changing the fuel connection at the test pump.

Generally, there are six bench tests which may be conducted on a nozzle. They are: (1) valve-opening pressure; (2) popping; (3) chattering; (4) dribble; (5) general leakage; (6) spray appearance. Table I indicates that not all nozzles will require all six tests.

Testing Open Nozzles

Open nozzles, under the definition of "open" as stipulated, generally involve check valves opening in the direction of flow. These are spring-loaded and usually have relatively low tensions. Two things should be known about them—opening pressure and sealing effectiveness.

Opening pressure can generally be determined by connecting the test pump to supply pressure in the normal direction of fuel flow. If the pressure is slowly built up, a pressure drop will be noted on the gauge when the valve opens and a spray will be delivered at the nozzle. On unit injectors such as the GM and Murphy units, it will be necessary to place the rack in the "no-fuel" position so that the fuel pressure is exerted through the pumping chamber to the check valve.

Opening pressures should be within the manufacturer's specified range. If not, replacement or adjustment is indicated.

Sealing effectiveness can be determined in two ways. The test pump pressure can be built up to a point just below the opening pressure and evidence of dribble at the nozzle noted. If a very light spring pressure is normal, the allowable pressure buildup may be too low to give positive indication. In such cases, it is necessary to apply the pump pressure to the nozzle tip in the reverse direction of fuel flow. High pressures can then be built up and the rate of pressure drop noted as indicative of leakage past the valve.

Cleaning will often remedy a leaking check valve. However if the seat or valve is damaged, repair or replacement is necessary.

General leakage may be detected by applying test pump pressure in the direction of normal fuel flow. In order to develop the necessary high pressures the orifices must be blocked. In the case of the unit injectors, general leaks can be detected and also the rate of leak-off past the high-pressure and metering plunger can be determined. In the case of the Cummins injector leakage past the plunger can be checked.

Leakage at various valve holder assembly joints may point to a poor seal between lapped surfaces or at copper gasketing. All such leaks must be corrected. In the unit assemblies, excessive leakage past the plungers will require replacement.

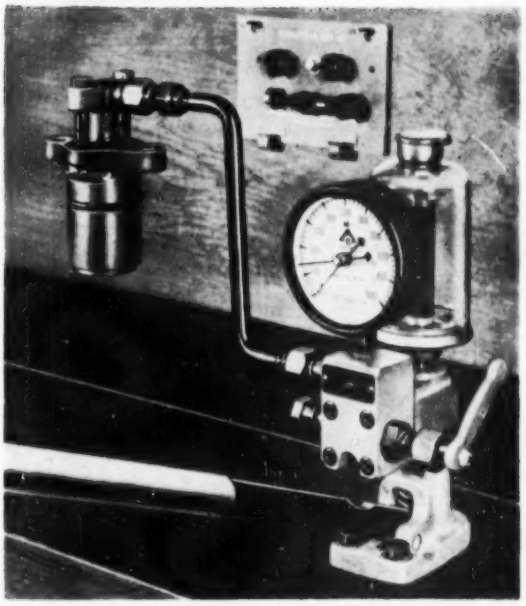


Fig. 5 Typical bench test setup for testing nozzles

Fig. 6 Setup for testing nozzles on the engine.

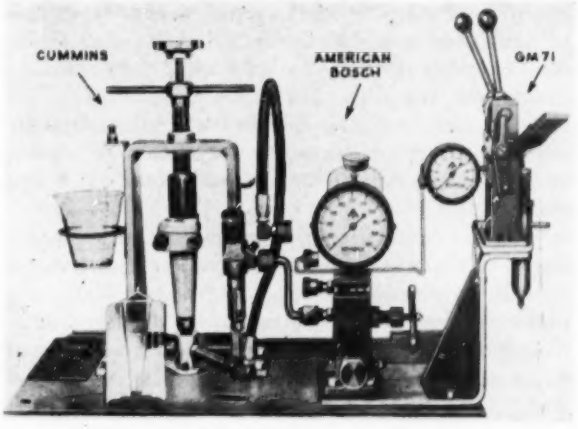


Fig. 7 Universal nozzle and injector test equipment.

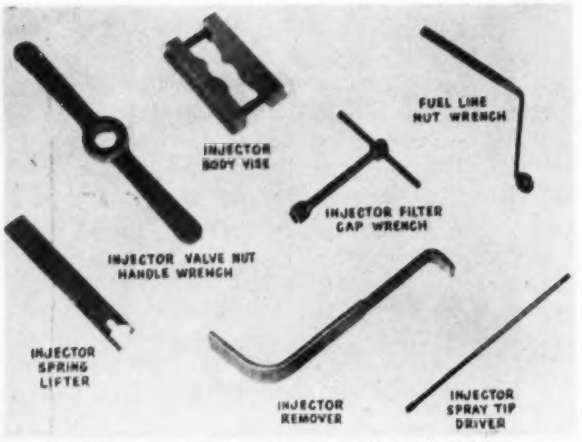


Fig. 8 Necessary tools for dismantling GM Series 71 injectors.

Spray appearance of all nozzles should be carefully scrutinized. A distorted spray indicates a clogged or eroded orifice. Since judgment is the criterion of this test, it would be best to compare the spray of the nozzle in question with that of an identical nozzle known to be in perfect condition.

In the case of unit injectors (including Cummins), it is convenient to produce sprays using the integral pumping equipment. For this purpose, holding fixtures and actuating levers (simulating the engine actuating mechanism) are used. It is also possible to check for general leakage with this equipment by blocking the orifices.

Testing Closed Nozzles

The closed, popping-type nozzle is a widely used variety. This nozzle should be tested for valve-opening pressure as already described. With this type of nozzle, the instant the valve opens a distinct "pop", which characterizes this nozzle, is heard. The popping pressure and the valve-opening pressure are one and the same. The valve opening may be at the specified pressure. However, if the nozzle does not pop, chances are it has a defective valve seat which can be verified by conducting the dribble test previously described.

Another test produces what it known as "chatter". A vigorous stroke on the test pump will produce a pop and a consequent sharp fuel discharge. If the pumping is slowed to the point where the nozzle delivery is a little greater than the pump delivery, the valve will "pop" open, discharge fuel, and immediately close again. Pressure will build up again and a similar cycle will follow. By altering the pumping rate, successive "pops" may be made to occur in such a manner that the nozzle sounds as if it is chattering.

While the inability to "pop" or "chatter" of a popping-type nozzle may indicate a faulty nozzle, this does not mean that the ability to "pop" or "chatter" of a nozzle indicates a good nozzle. A nozzle with a leaking valve or eroded valve stem can be made to chatter with proper pumping speed. Furthermore the American Bosch throttling-type pintle nozzle which is of the popping variety sometimes cannot be made to chatter even though it may be

Table I Recommended Nozzle Tests

Make of Nozzle	Popping & Chattering	Valve-Opening Pressure	Spray Pattern	Leakage at Tip (Dribble)	Internal Leakage
American Bosch	x[1]	x	x	x[2]	
Bendix-Scintilla	x	x	x	x	x[3]
Caterpillar	x	x	x	x	x[4]
Cummins[5]		x[6]	x		x[7]
Demco	x	x	x	x	
GM[5,8]		x	x	x	x[9]
I-H		x		x	
Murphy[5,10]			x[11]		x[12]

1. Throttling pintle must be tested at 100 test pump strokes per min. This type may not chatter.
2. Considered tight if no leakage occurs within 200 psi of valve-opening pressure. For throttling pintle within 300 psi of valve-opening pressure.
3. Pressure drop from 3000 to 1000 psi in not under 15 sec.
4. "Capsule" type valves only. Limited to pressure drop from 200 psi to 100 psi in not less than 30 sec.
5. Unit Injector (mechanically-operated nozzle).
6. This is checked in fuel inlet tube.
7. Check valve should hold 2000 psi applied at nozzle tip. Plunger leakage should not exceed 6 cc per min at 2000 psi.
8. Test with rack in full "Fuel on" position.
9. At pressure just below opening-pressure, drop should not be more thas 200 psi in 50 sec for new injector and 200 psi in 35 sec for used injector.
10. Must deliver from spray collector nut one drop of fuel for each 5 test pump strokes when control crank is in slot in setting block.
11. Test with control crank full open and spray collector nut off.
12. Observe bubbles when 75 psi air applied to body and submerged in fuel oil.

in perfect operating condition. This nozzle also presents an exception to the dribble test in that if pumping rate of the tester is less than 100 strokes per min, the throttling action of the nozzle may cause it to dribble and eject flags—which does not necessarily mean it is defective. If dribble does not occur within 300 psi of the valve-opening pressure, the valve may be considered tight. Other nozzles may show moisture at the nozzle tip with slow pumping speeds. At the high-speed injection rates when in operation this little moisture is insignificant.

A check for leakage and spray pattern comparisons should also be made as previously described.

General Precautions When Testing

Certain general precautions must be observed when testing any nozzle. For convenience, these are listed as "Do's" and "Don'ts"

DO'S

1. Always clean nozzle holder, connection and lines in the vicinity of the holder with clean fuel before breaking any connections or dismantling.
2. Cap all fuel openings with lintless rags, paper, or shipping plugs as soon as the nozzle is removed. This includes the injector, lines, and the cylinder head injector cavity.
3. Clean the nozzle tip externally, making sure that no carbon particles enter orifices or pintle hole before testing. Use only brass wire brushes (sparingly), solvents, or wooden sticks soaked in fuel oil to clean the tip; use nothing hard or sharp.
4. Consult the engine or injection equipment manufac-

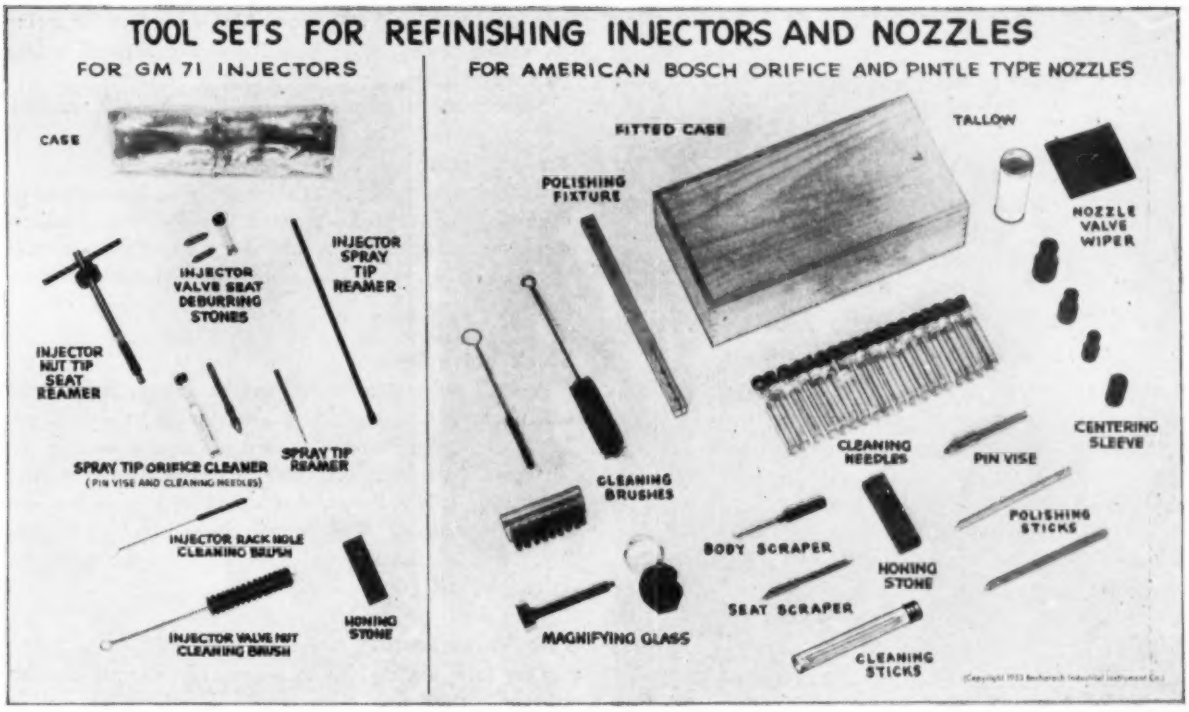


Fig. 9

turer's maintenance manual for details on testing the nozzle.

DON'TS

1. Don't grab the nozzle holder in a vise, as this may distort the body enough to cause binding of moving parts. Use the holding fixtures specially designed to hold the particular unit being tested.
2. Do not allow the nozzle spray to contact the skin. Pressures can be sufficient to penetrate the skin and cause blood poisoning.

Table I provides a summary of the tests which should be conducted on various makes of nozzles. Note that no attempt has been made to be specific in listing valve opening pressures for the numerous models of each manufacturer. Such a list would be rather pretentious.

Servicing Nozzles

Wherever nozzles are to be serviced, specialized facilities must be available. No attempt should be made to dismantle a nozzle unless some reasonable approach to the following conditions can be made.

1. Surroundings must be clean. This cannot be emphasized enough. Manufacturers make and assemble their nozzles in an air-conditioned dust-proof atmosphere. Floors and work benches should be scrubbed each day. Clean. white, heavily-starched lab coats should be worn.

2. The following special-purpose tools are absolutely necessary. (a) Special dismantling tools (Fig. 8) are required to make certain that nozzles or injectors are not damaged during disassembly or reassembly. (b) Refinishing tools (Fig. 9) are needed for performing the cleaning and refinishing operations specified in the manufacturer's maintenance manual. (c) Testing equipment (Figs. 5, 6, and 7) is necessary to determine what is wrong with the nozzle, and after servicing to determine whether the nozzle is restored to perfect condition.

3 Clean, dry compressed air for cleaning is essential.

4. Clean highgrade fuel and solvents must be on hand. Glass dishes make convenient, easily cleaned receptacles for cleaning baths. Solvents such as petroleum, ether, or acetone are readily available. Carbon tetrachloride should be avoided because it can be dangerous if the fumes are inhaled over prolonged periods.

The first step in servicing a nozzle is to test it. This will indicate what must be done to remedy any defects which may show up. The trouble may be incorrect valve spring tension, broken valve springs, stuck valve stem, poor valve seating, eroded valve stem, eroded orifices or pintle holes, or clogged openings. Of course, all of these defects do not pertain to all types of nozzles.

Valve-Opening Pressure

Incorrect check valve opening pressures in the open nozzles are generally corrected by replacement of the spring, or in some cases a complete check valve assembly.

If the valve-opening pressure of a closed nozzle is incorrect, adjustment may be made by means of an adjusting screw and lock nut. The opening pressure may be raised by increasing the spring tension and lowered by decreasing the tension. Shims may be added or removed from the spring seat in the absence of an adjusting screw. Ordinarily the spring tension will have to be increased.

American Bosch recommends that the valve-opening

Fig. 10a Method of scraping the nozzle seat.

Fig. 10b Polishing the nozzle seat

Fig. 10c Cleaning and polishing the nozzle valve.

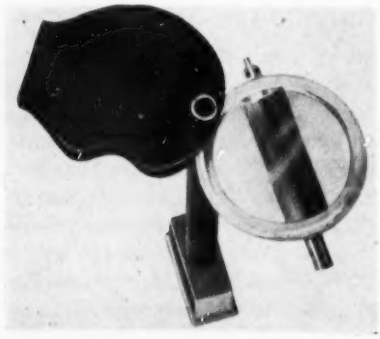


Fig. 11 A magnifying glass is helpful when inspecting parts.

pressure be adjusted 10 per cent higher to allow for spring set when a new spring is used. The spring will tend to take on a set with usage.

Some nozzles are not adjustable; these must be replaced.

Broken Spring

Broken valve springs will show up as an incorrect valve opening pressure. If the pressure is insensitive to adjustment, the cause may be a broken spring or a stuck valve stem. In either case, disassembly will be required to trace the defect.

Stuck Valve Stem

A stuck valve stem should not be forced. If it is not easily removed, it should be soaked for six or eight hours in a solvent. Care should be used not to mar or chip the surfaces. If the stem still remains unmoved after careful persuasion, it is probably warped and both valve and seat should be replaced. Warping may be caused by overheating, which will result in a bluish coloring of the nozzle tip, valve seat, and valve.

Poor Valve Seating

Poor valve seating will be indicated by the dribble test. Dirt or varnish may cause dribble, or the valve seat or stem may be worn or eroded. In the latter case, no easy remedy can be applied and both parts must be replaced. Dirt or varnish can be cleaned.

A brass seat scraper (Fig. 10a) should be used to remove the hard carbon. After removing the large carbon particles from inside the nozzle, a round pointed wooden polishing stick dipped in tallow should be rotated in the seat (Fig. 10b). This polishing operation will remove tarnish and restore the seat to its original fineness unless, of course, scratches exist. The valve should be cleaned and polished in much the same manner using a wooden polishing fixture with holes drilled into it (Fig. 10c).

Polishing should not be overdone and care must be taken to remove all tallow from polished surfaces.

Reconditioning of valves and seats beyond this point is not generally recommended unless special skills and special equipment are available. Conceivably a poorly seating valve can be relapped; however it is a ticklish procedure. The valve angle and seat angle are generally one degree or so different. In this way, a line contact is approached giving high unit pressures for good sealing. Improper lapping may result in a greater contact surface which would destroy the sealing properties. A high precision lathe or special lapping machine with practically zero runout would be necessary.

Scored Valve Stem

A scored or otherwise damaged valve stem is frequently made apparent by leakage tests. Although this is a fairly sure test for scored valve stems, the stems should nevertheless be closely examined under a strong magnifying glass (Fig. 11) when the nozzle assembly is dismantled, regardless of the reason. There is no cure for scored stems; therefore valve and nozzle body must be replaced.

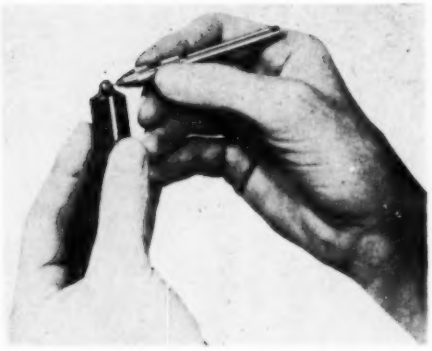
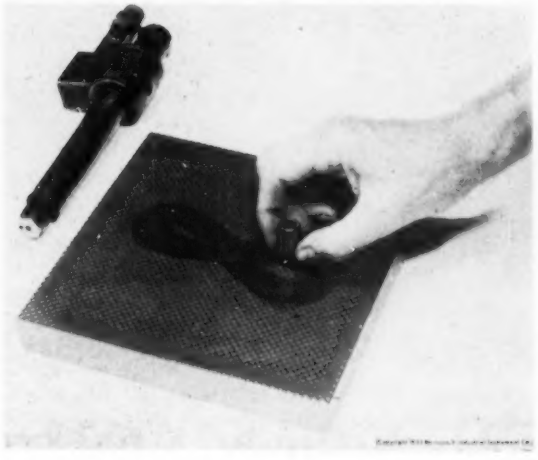


Fig. 12 Method cleaning the nozzle orifices is shown at left

Fig. 13 Lapping flat surfaces of GM "71" injector parts. (lower left).

Fig 14 It will be noted that in flat-lapping the Bosch nozzle parts (below), the same motion is used on the lapping plate.



Cleaning Nozzle Orifices

The magnifying glass should again be used to inspect the condition of orifices and pintle holes. The spray pattern test will, of course, be irregular if these are eroded or clogged. However, the observer may not be able to detect a very slight distortion of the spray pattern. The magnifying glass should bring out small defects. Eroded openings (enlarged or oblong orifice or non-concentric pintles) must be replaced. On the other hand, clogged orifices may be cleaned by using special cleaning needles. The needle diameter should be slightly smaller than the orifice diameter. Consult the engine manual for these diameters.

Prior to cleaning nozzle orifices, carbon and varnish should be removed from inside and outside the nozzle. The appropriate scrapers or drills and brass wire brushes should be used. Internal cleaning and clearing of the holes will be facilitated by first soaking the nozzle in a solvent.

Certain precautions must be observed when using an orifice cleaning needle. The needle should be inserted in a pin vise so that it protrudes about ⅛-in. The needle must then be honed to remove all burrs. Carefully push the honed needle into the nozzle orifice taking care that the pin vise is held at the correct angle to follow the orifice as it was originally drilled (Fig. 12). If the orifice is difficult to clear, shorten the needle in the pin vise so that there is less chance of breaking off the needle inside the orifice. Extend the needle a little at a time until orifice is opened clear through.

The opening for the pintle-type nozzle may be readily cleaned by using a small wooden stick dipped in tallow.

Lapping Flat Surfaces

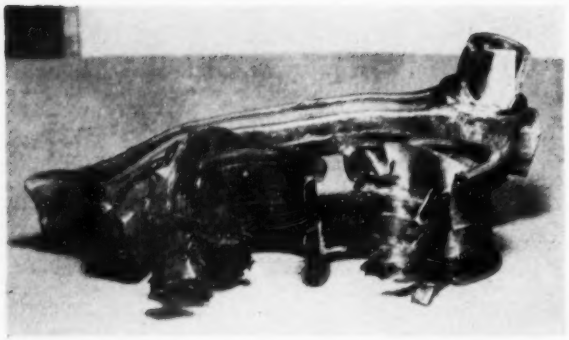
Practically all makes of injector nozzles depend upon lapped surfaces to seal between the related parts. All these surfaces must be clean, highly polished, and absolutely flat so that each joint will stand the full injection pressure without leaking.

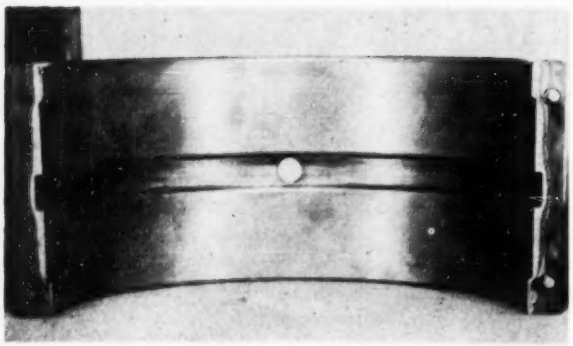
Lapping of surfaces such as these requires some degree of skill, and rejected parts should be used for practice. Lapping blocks should be kept in A-1 condition at all times. Avoid unnecessary lapping. The parts should have a fine mirror finish and only those parts whose surfaces must be restored to this high degree of finish should be lapped.

Figs. 13 and 14 illustrate how parts should be held on the lapping block. The part is held low and just sufficient pressure applied to hold it flat on the lapping block. Notice that a figure "8" motion is used. Only four or five passes should be made at a time, cleaning and inspecting the part each time.

Reassembly

After all parts have been cleaned and refinished closely following the manufacturer's recommendations, the nozzle may be reassembled, again making use of the appropriate tools. Fig. 9, for example, shows the special centering sleeve which is very necessary for the assembly of the American Bosch nozzle. After reassembly, the nozzle must be tested again following the procedures outlined. If the nozzle is to be stored, special preservative fluids should be circulated through the nozzle and all openings tightly capped.





Figs. 1 & 2 show a striking comparison of a failure and a long-lived locomotive bearing which has seen 1,000,000 miles of service.

This
or
This It Can Be Up To You

By E. Crankshaw and W. Weinkamer

Cleveland Graphite Bronze Co.
Division of Clevite Corporation

Visually Analyzing Bearing Troubles

A psychologist will tell you that machines may be complex but never emotional and that you can drive a car but you must manage people, but a psychologist is not an engineer. You know and I know that machines can be temperamental and that a *managed* engine will perform better than a *driven* one. We, in the bearing business, can take a leaf from the psychologist's book however, for we have learned that the "proper approach" will make an engine with a "bearing breakdown" tell what was done to it in its childhood.

Three logical steps should be taken in a complete search for a solution to poor bearing performance. Keeping in mind that bearing trouble may be an indication of trouble elsewhere the procedure should include: first, visual analysis of the bearings and related components; second, metallurgical and chemical analysis of the bearings and lubricant; and third, a review of the designs, the loads, and the lubrication.

Time is often an important factor, and it may be necessary to perform only a visual analysis in order to get the equipment in use. In ninety per cent of the cases of failure, visual analysis alone usually will be sufficient to determine the cause. This is possible however, only if the clues have not lost their true identity or have not been destroyed by the failure on the part of the operator or mechanic to realize the importance of preserving all of the story the engine parts have to tell. Before proceeding with failures recognized by visual means, let us review briefly the most common causes of bearing failure.

Bearing failures may be catalogued into five general classifications. In the general order of their frequency of occurrence these are:

1. *Fatigue*
2. *Wiping and Seizure*
3. *Corrosion*
4. *Wear and Scoring*
5. *Erosion*

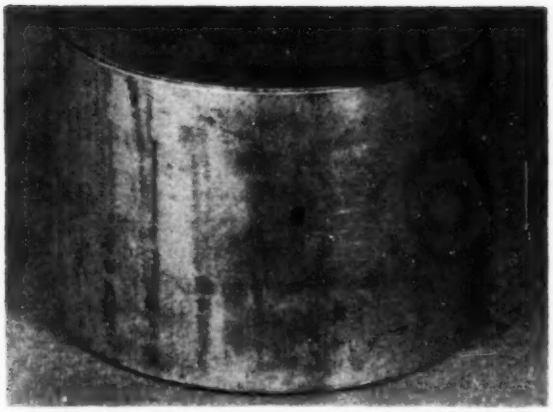
Rather than to identify each of these types of failure in great detail, let us instead determine what the common factors are that cause these types of failure in actual engine or field operation.

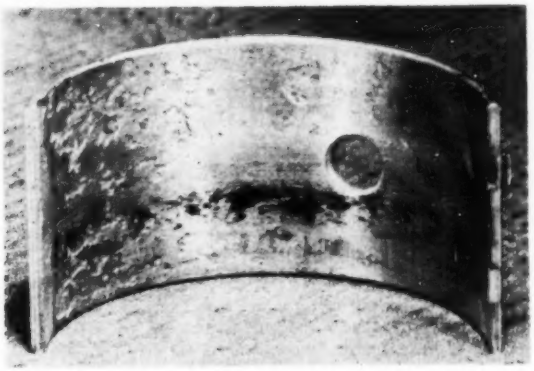
Fatigue

Let us consider first, fatigue. Normal bearing fatigue is characteristically located uniformly across the bearing from edge to edge in a random pattern and ordinarily only in a centrally located circumferential direction about 30 deg either side of the vertical center line.

Fatigue in its primary stage is characterized by many fine cracks which work their way from the bearing surfaces to the bond line between the lining and the backing material. The secondary effects occur when the cracks parallel the surface and join other vertical cracks to lossen complete sections of liner, there finally breaking out into small enough pieces to enter the clearance volume between the shaft and the remainder of the original bearing surface.

Fortunately, most of the cases of fatigue that result





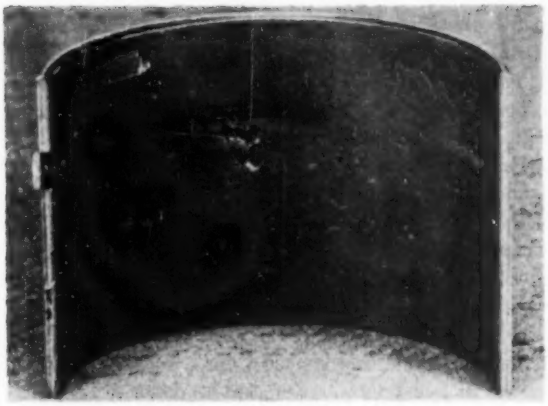


Fig. 3 (upper left) and Fig. 3a (above illustrate the result of dirt on a bearing back. The shell is pushed inward and the clearance reduced. Fig. 4 (left), shows fatigue due to dirt on the bearing ID.

from improper assembly and careless maintenance conditions can be isolated by visual analysis and corrected if the engine and its components are available for examination. Essentially, since fatigue results from continual cycling above the time-load capacity of a given material, an unanticipated load concentration is responsible for the failure.

Dirt or foreign material is the number one enemy of sleeve bearings. Dirt is particularly troublesome in that it can cause almost all of the types of failure and not reveal its presence unless the failure happens to be examined at the proper stage. There are several ways that dirt can cause load concentration and fatigue.

Figs. 3 and 3a illustrate a case where dirt has lodged between the back of the bearing and the rod or case bore. The foreign material prevents the bearing back from being seated. Consequently, the shell is pushed inward and the clearance space originally provided is reduced.

This results in localized high unit loads, breakthrough of the oil film, and excessive localized bearing temperatures. The bearing material in these localized areas will then either melt or fatigue prematurely. When the foreign particle size behind the bearing back is large enough, the failure will not be localized as shown but will result in a completely wiped-out bearing shell.

Naturally, the proper method of correcting this failure is to make certain that all surfaces are clean when the assembly is made. Examination of the back of a bearing which shows local fatigued areas will usually show quite clearly whether there has been any dirt or foreign material on the back. Frequently the dirt remains in place, flattened out or partially dug into the steel. If the dirt has escaped, usually there is a darkened area or a discolored oxidized spot immediately under the ID surface where the dirt has caused the fatigue.

The appearance of dirt on a bearing ID surface also has an effect in reduction of bearing fatigue life. The increased friction resulting from an irregular dirty surface may cause a rise in operating temperature of the bearing, which will in turn reduce the fatigue resistance of the material. As an example, the life of a tinbase babbitt bearing is approximately doubled by reducing the bearing back temperature from 280°F to 250°F.

Fig. 4 shows effect caused by dirt and grit on the ID. Since babbitt is not compressible, the large foreign particles or dirt particles, as they are imbedded, displace the babbitt and push it up around the dirt. The high portion of the babbitt is then the point where the load is concentrated. Subsequent partial interruption of the oil film causes excessive heat along with accompanying fatigue. So in this case there are two effects which reduce the fatigue life of the bearing material.

Misalignment at assembly causes load concentration and premature fatigue. Such a condition may result from poor manufacturing tolerances as in cases of connecting rod bend caused when the bore of the large end and the small end are not parallel, or cases of whip, or deflection in the journal. It may result, as in the case of Fig. 5 from a tapered shaft, or as in Fig. 6 from an hour glass-ground journal.

These conditions may be isolated by a dimensional check of the suspected part. The best insurance against such failures is maintenance of good manufacturing and regrinding standards for journal and bore taper, parallelism and roundness.

Poor bond between the backing material and the bearing alloy is not a common occurrence. Whereas fatigue is characterized by many fine cracks in the area of failure,

poor bond (Fig. 7) usually results in a clean break of larger section.

Failure in copper-lead or trimetal bearings may appear at first glance to be caused by poor bond. Closer examination will reveal that frequently extreme operating temperatures have actually weakened the bond by reducing its resistance to fatigue. Dark discoloration of the steel at the original bond line indicates subjection to excessive temperatures. When possible it is better to analyze the bearing metallographically and not depend on visual examination alone for positive identification.

Summarizing the discussion of identifying the causes of premature fatigue, remember that it occurs primarily because of load concentration and secondarily because of high operating temperature. Best method of isolation of the cause is a careful check of the bearing assembly for "off" conditions.

Wiping and Seizure

Basically, wiping or seizure results from a lack of a complete oil film between the journal and bearing. This may be a temporary condition which does not lead to complete bearing failure, or it may be a progressive type of failure which ends in complete disruption of the bearing surfaces.

While identification of wiping and seizure is relatively simple, determination of its cause by visual analyses is not as easily accomplished. Babbitts and the heavy-duty materials act quite differently in response to conditions initiating surface distress because of the difference in hardness of the materials. Increase in fatigue life gained by the heavy-duty copper-lead, silver, and related materials is accomplished through some sacrifice of surface running characteristics.

Complete seizure of babbitt bearings is rare and happens only if the engine operator fails to notice an accompanying loss of oil pressure, temporary increase in operating temperatures, and increased level of engine noise. If seizure does occur, the journal may weld to the steel back after the babbitt has been melted, as has happened in the example shown at the beginning of this discussion (in Fig. 1). More commonly, surface distress results in a wiping of the bearing.

Dirt imbedded in the babbitt bearing, to a degree greater than the babbitt can effectively swallow, will score and abrade the bearing journal and increase the surface temperature, with the results shown in Fig. 8. Determination of the type of dirt may some times be made by use of a magnet when these particles are isolated from the bearing. Best clues as to the source of the material lie in examination of the engine and its parts.

Insufficient initial clearance causing a wiped bearing surface is shown in Fig. 9. A good bearing surface operating under satisfactory conditions has a dull appearance. In many cases the surface is coated with a varnish formation or a protective film of various shades depending on the type of oil used. When, as here, the surface is shiny or lightly wiped, the oil film has not completely separated the bearing lining and journal.

Analyses for the cause should include investigation of operating temperatures and measurement of mating parts for improper assembled clearances. Micrometer measurement of the bearing wall alone is not sufficient to determine proper clearance in a given bore. Accurate measurement of the bearing assembled in the bore should be made since the press fit of the bearing usually distorts the bore to give increased clearances over those obtained by theoretical calculations.

Fig. 5—Results of edge loading due to a tapered shaft (left).

Fig. 6—Misalignment—effect of an hour-glass journal (lower left).

Fig. 7—Fatigue due to bad bond is illustrated below.

Fig. 8—Dirt and high temperature caused the condition at right.

Misalignment between the journal and its bearing may cause wiping and subsequent seizure. This happens because the load is not distributed and the resulting edge pressures force the shaft to break the oil film.

Fig. 10 shows where a tapered shaft has caused a partial decrease in clearance with resultant wipe of the babbitt until a new surface has been produced which will redistribute the load over a greater area. This is one condition in which babbitt has an advantage over high fatigue strength alloys.

Corrosion

The most difficult type of bearing failure to identify by visual methods is corrosion. Actually, complete metallographic checks combined with X-ray and bearing fracture tests are required for positive identification since the structural changes cannot be seen with aid of relatively low-power magnifying lenses.

Corrosion is doubly difficult to detect because it frequently results in early fatigue because of a weakened structure. The best visual clue offered for identification is in the location of the surface distress. Generally, except in cases occurring because of exposed protective layers, corrosion will attack the complete bearing surface while fatigue is more usually concentrated in a given area.

Cases of lead-base babbitt corrosion are rare (corrosion of tin-base babbitt is practically unheard of), but possible with some lubricants (see Fig. 11). A fine greyish, powdery surface may result. The unloaded half of such a bearing assembly may be wiped with the fingers under heavy pressure with resultant transfer of powder off the babbitt. Wash of this material by the lubricant transfers it through the lubrication system where it may appear as deposits in radii, pump and filter screens, or as a grey coating in the oil pan. In such cases, if corrosion is suspected, a sample of the oil submitted for chemical analysis will aid in detection of corrosive by-products.

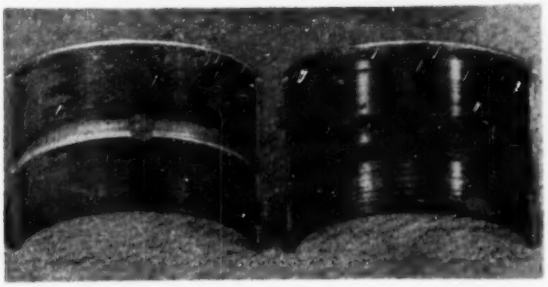
Corrosion of copper-lead bearings presents a more serious problem when attempting to find the cause. Abnormally high engine temperatures on one hand cause rapid increase in oxidation of lubricants, while continued cold operation also can result in formation of corrosive elements from decomposition of fuel in the presence of crankcase condensation. Such operating conditions are not easily traced back to bearing condition after failures have been detected.

The overlay of the trimetal bearing not only is effective in reducing surface sensitivity to seizure and increasing fatigue life, but also offers protection from corrosion. Because of the usually good resistance of babbitt to corrosion, the copper-lead layer is not exposed unless the overlay is scored or worn through. When the copper-lead layers are subject to corrosion, the free lead between the copper dendrites is ordinarily the element attacked.

Usually, this leaves a red appearance to the surface, and for that reason a metallographic, X-ray, and fracture analysis is the only certain method of identification. Scratch penetration of several successive layers may be of some use for visual determination, but it is only a tool for use by one who is widely experienced since there is a possibility of overlapping of color shades leading to confusion.

The bearing shown in Fig. 12 had a bright red appearance characteristic of lead corrosion. Most cases of corrosion, unfortunately, are accompanied by surface

Fig. 9—Insufficient clearance caused the wiping shown below.



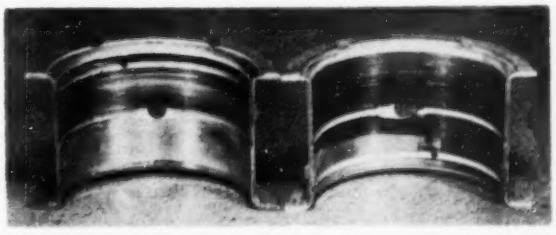
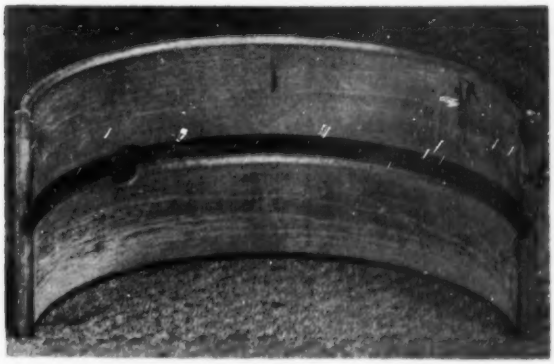


Fig. 10—The condition above is due to misalignment or tapered shaft.

Fig. 11—Illustrated below is the corrosion of lead-base babbitt.



deposits which fill up the deleaded cavities and are not removed by ordinary cleaning solvents. These deposits, usually sulphides, at first glance may be confused with protective deposits from oil additives, but the latter may be easily removed by ordinary solvents whereas corrosive byproducts are difficult to clean out of the pits in the surface.

After corrosion begins, the normal structure is weakened and continued breakdown of the surface will lead to premature fatigue failures, as shown in Fig. 13. This type of failure is often confused with ordinary fatigue by the uninitiated.

Fretting corrosion which is not peculiar to bearings but may occur on any two mating machine parts, appears in a form typified by its descriptive name. It most frequently appears on applications where the journal and bearing are thought to have little relative motion, but where induced or forced vibrations are present. Common examples of such applications are on guide bearings, axle bearings, and king-pin bushings.

The high frequency vibrations present in such applications may breakdown the lubricant film and cause direct transfer from one metal to the other. Prolonged fretting between the two materials may result in a dark oxide formation in conjunction with a disruption of the surface. When such cases are suspected, the direction and location of the load should be examined and a search for a possible source of induced vibration should be made.

Wear and Scoring

Wear and scoring may be a particular type of failure by itself or more usually, it is only an intermediate stage which will progress further to wiping, seizure, or premature fatigue, depending on the type of bearing material and the severity of service. The majority of all bearing failures, as has been suggested, are initiated by the introduction of dirt into the engine lubricant.

Visually, there is no problem in identifying wear and scoring of the bearing, as in the case of Fig. 15, since the degree of wear is easily checked by micrometers and scoring is more than obvious. The source of the foreign particles is a different matter. Here again it is extremely important to have access to the engine in order to locate the origin of the dirt.

Operational and overhaul history of the engine should be examined. The most frequent source of dirt is from improper cleaning of the engine during maintenance. In such cases, metal chips, or grinding or lapping compound may not have been carefully removed. Such material in a bearing surface may abrade and wear shafts as well as lap the bearing surface. This results in excessive clearances and high oil consumption.

Proper maintenance of filters is a must. Loaded filters may bypass dirt-laden oil in a sludged engine and result in temporarily increased oil flows which will carry unusual amounts of deposits to the bearings in slugs. Steady flow of dirt is bad, but slugs can be fatal in a short time.

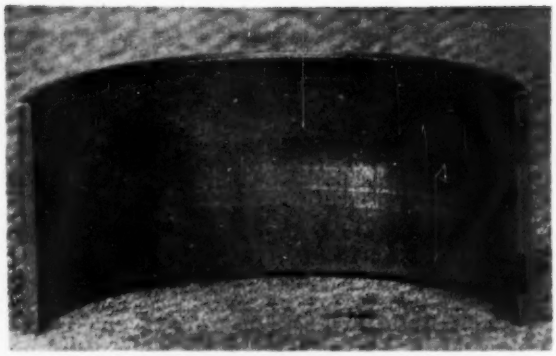


Fig. 12—Characteristic of lead corrosion is its bright red color.

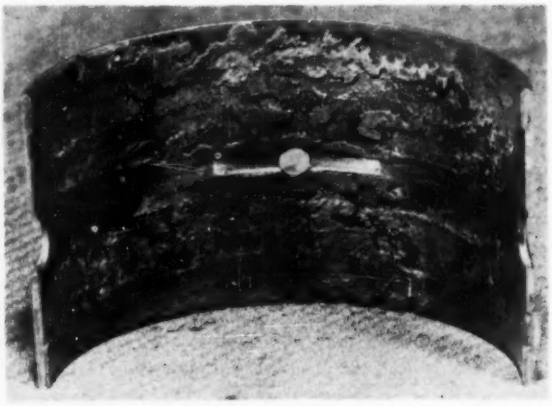


Fig. 13—Corrosion and later fatigue caused this condition.

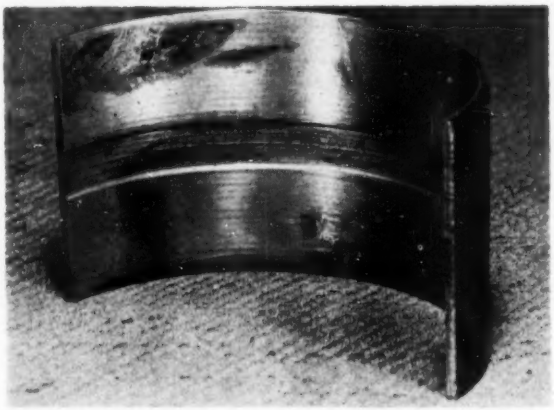


Fig. 14—Fretting corrosion may also occur in other mating parts.

Fig. 15—Below, an intermediate stage of scoring by dirt.

Similarly, poor rings may pass hard carbon particles in blow-by and result in contamination of the crankcase with hard particles as well as sludge. Consequently, maintenance of the rest of the engine will have a marked effect on bearing performance.

Needless to say, proper air filtration in crankcase breathers is as important to bearing performance as is combustion air filtration. Clean air and clean oil mean increased bearing performance, quieter operation, and less oil consumption.

It is not difficult to understand why more serious degrees of failure occur from wear and scoring light of the previous discussion on wiping and seizure.

When shaft surface finishes are too rough, the high peaks of the journal may actually contact the bearing surface when the oil film thickness reaches its minimum value. In the case of babbitt, the grind pattern on the journal may be transferred to the bearing surface as shown in Fig. 16. On the other hand, a heavy-duty bearing may not react by wearing but by seizing.

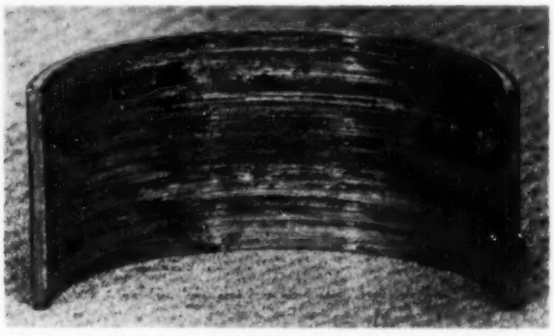


Fig. 16—Result of a rough shaft on a copper-lead bearing (above).

Fig. 17—Erosion in a gear bushing is shown at right.

Erosion

A more infrequent case of bearing failure is erosion. It may appear in a simple form with a washing action on the bearing surface leaving a hen-tracked pattern probably from foreign particles in the lubricant. Or it may appear as a mysterious phenomenon popularly called "cavitation erosion". Frankly, I am not sure that true cavitation theory of vapor-bubble collapse in the lubricant can be applied to bearings, so I would hesitate to give a theoretical discussion on the developement of such failures. Let's just call it erosion.

In Fig. 17 you see an advanced case of erosion in a cut-open bushing from a gear train component. Careful visual analysis with a low-power magnifier will show an irregular depth to these pitted areas. In general, erosion leaves the bottom and sides of such cavities much smoother than similar cavities produced by fatigue and with freedom from tell-tale cracks.

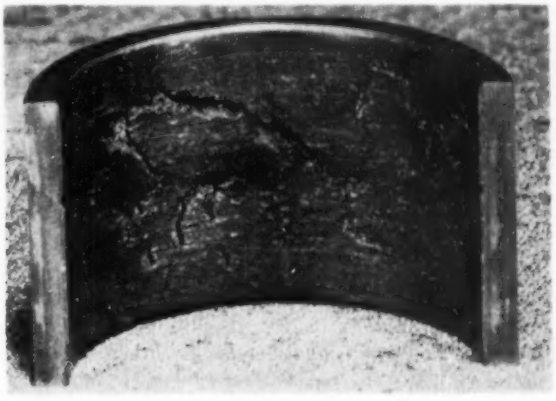
This type of erosion is most commonly found in bearings associated with gear trains, or applications of high rotational speeds with high-frequency shock loads. In the case of gear trains, such things as changes in lubricant viscosity, breaking up the velocity of lubricant flow, and improving gear tooth engagement have improved bearing performance.

One of the really mysterious things about erosion is that it does not stop with the relatively soft bearing material. In systems where it appears it may attack mating parts as well. It has been known to eat into steel shafts and cause fatigue failures of high-speed rotating parts as well as appearing in a simple form.

Conclusion

After having covered just a few of the ordinary things that can happen to a sleeve bearing you are probably ready to throw in the towel. Actually, things are not as deplorable as has been indicated. Most failures occur from faulty maintenance and abuse of engines.

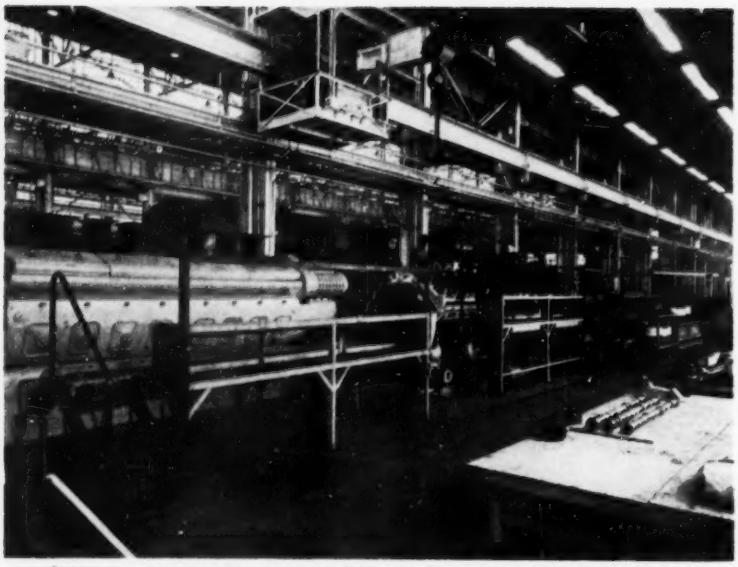
I might say never before has the engine operator "had it so good". There are many, many engines to chose from to satisfy his wants. He probably has more trouble deciding which one of many available power plants to use than he has trying to find one which will fit his application. Today's engines are lighter, smaller, have more horsepower per pound and per cubic inch, and have longer lives than ever before.



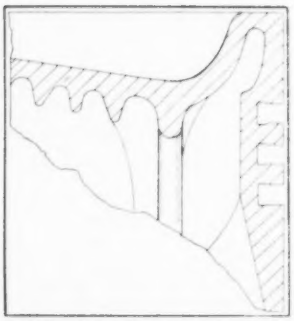
In order to keep abreast of these developments, the bearing specialist has had to revise and modernize his approaches to bearing design. Now he is able to offer the engine designer complete design service based on preliminary lubrication and load studies.

These design studies, offered by most sleeve bearing manufacturers, are primarily to establish proper bearing operating temperatures and oil flows to give good bearing life and to establish proper dimensions which will prevent mechanical failures during the life of the engine. The rest is up to you.

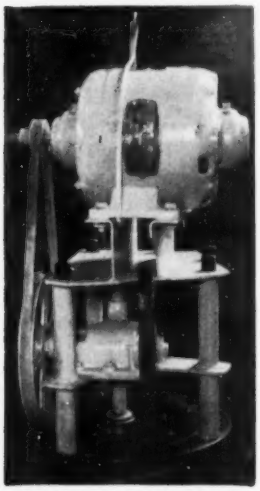
Let me close with a bit of advice for those who are confronted with bearing trouble and have to analyze it. Save every clue! If possible, lay out the components on a large table in their relative assembled positions, examine the good pieces as well as the failed ones, and try to correlate engine history and performance with the story bearings have to tell. Keep an open mind and don't be too quick to pass judgment for not always is a bearing's condition of its own making.



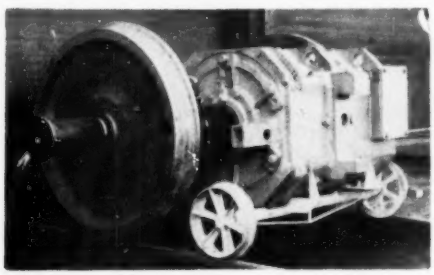
Engine assembly department at the Glenwood, Pennsylvania shop on the B & O.



Schematic diagram of the B & O's method of undercutting compression ring grooves.



Above is the setup developed to power the standard cylinder liner ridge reamer. Below is the traction motor dolly also developed by a B & O employee.



Maintenance Hints From the B&O

WE can all benefit by experience. Oftimes when a seemingly new problem arises in the maintenance department, someone may remember how the trouble was remedied in another shop or on another road. Following are abstracts from minutes of a meeting of the Central Railway Club of Buffalo on "Power Assembly Troubles and Remedies (EMD 567 engine)", addressed by E. H. Averill, general foreman, Buffalo Creek Shop, Baltimore and Ohio Railroad; and abstracts of the B & O MAGAZINE, Perhaps you will benefit from some of the remedies discussed and some of the special tooling developed by B & O personnel.

In addressing the meeting, Mr. Averill first reviewed some of the earlier troubles and their remedies. The first of these was the problem of cracked piston crowns, which has been remedied by the manufacturer's adoption of a floating piston design. Carbon deposits and buildup posed another problem when engines were lubricated with mineral oil. This trouble was eliminated for the most part by the use of detergent lubricating oils.

Piston Ring Wear

Then he dwelt at some length on later troubles involving bald compression piston rings—rings worn below the "Ferrox" grooves—together with corrective measures. This condition caused pulling of power assemblies long before necessary, due to broken and sticking rings.

Investigation disclosed that considerable dirt and dust of an abrasive nature was getting into engine air boxes. Three changes were made to better this condition.

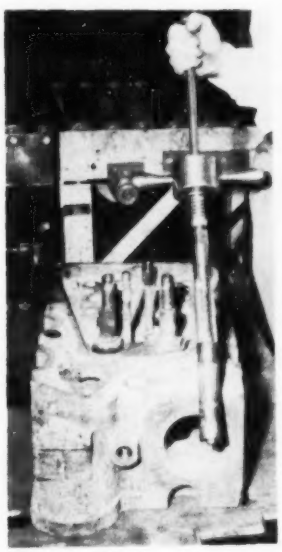
1. Adopting use of a "tacky"oil instead of plain lubricating oil for coating panel-type car body and engine intake filters, was one. This "tacky" oil was made at B & O Mt. Clare shop, Baltimore, by filtering used crankcase drainage oil and adding a heavy residue of a resin base. It was found that filter efficiency was greatly increased by the use of this viscous coating.

2. Engine air intake filters were increased in thickness from two to four inches. This necessitated redesign of filter housing, but resulted in less abrasive material entering the engine rooms and engines.

3. An additional sanding valve was installed to permit sanding of front wheels only. This eliminated the cloud of highly abrasive dust which was formed when all sand-

Another labor saving device is a jig for depressing all four valve springs on an EMD cylinder head simultaneously.

Below, a tool for pulling injector nozzle sleeves is illustrated. The tool consists of a tap and heavy sliding handle and is used on Alco heads.



At right, rebuilt cylinder liners and heads are stored in special racks, fabricated in B & O shops, to facilitate handling.

ers operated while the locomotive was moving slowly on a heavy grade.

In addition to causing excessive wear of truck parts, some of this abrasive dust found its way through car body filters into the engine room, and a sufficient amount of the finer dust particles went through the engine air intake filters into the engine, causing excessive wear on piston rings.

Single sander application consisted of the installation of an additional sander operating valve and some additional piping connected to the original sanding arrangment. This single sander delivers sand to rails ahead of front wheels of the "A" unit only. Under many conditions, sanding ahead of the lead truck has been found to be adequate.

When unusually bad track conditions are encountered, the original main sander operating valve may be used, which results in sand being delivered to the rails ahead of both trucks of all units.

Results on locomotives equipped with front wheel sanders (now adopted as standard on B & O freight units) are considerably cleaner engine rooms. Less sand dust gets into electrical cabinets and other electrical equipment. In addition to this, wear of piston rings and other engine moving parts has been reduced.

Operating tests show that the amount of sand used has also been reduced. In some areas, sand servicing requirements have been reduced to 50 per cent of previous consumption.

Stuck and Broken Rings

Undercutting of compression ring grooves was tried with a view of eliminating, for the most part, broken compression rings which seemed to be caused by a combination of stepped ring groove wear and carbon build-up in the ring groove.

Mr. Averill said, "We now have over 800 of these undercut pistons applied to our engines and have found that our stuck and broken compression ring problem has been practically eliminated."

This practice, however, has not yet been extended to the entire railroad, according to recent advise from Mr. A. K. Galloway, general superintendent, Motive Power and Equipment. He also advised that although considerable advantage has been realized from use of this undercutting on the Buffalo Division, full advantages are not possible until such time as the locomotive builder accepts this improvement and furnishes pistons with undercut compression ring grooves. Adoption of the practice by the builder would permit the strengthening of the piston ring by replacement of metal now removed by beveling both sides at inside of diameter of ring.

Labor Saving Devices

Mr. Averill then digressed to talk of two machines designed at Riker shop, Punxsutawney, Pennsylvania, one of which has been built and in service for some time.

The first machine described was a standard cylinder liner ridge reamer for the 567 engine, redesigned to include an electric powered drive. Mr. Averill explained that when using the hand-operated ridge reamer, with automatic feed, it takes a machinist approximately one hour to remove one liner ridge. With the electric drive developed at Riker shop, a machinist can remove ridge in one liner in about 10 minutes. This saving of 50 minutes represents a dollar saving of $1.58 per liner.

A power driven valve seat reamer was described next. This unit is designed to machine the valve seat counterbore on all four exhaust valve openings simultaneously. It has been designed and construction has been started, but not as yet completed.

With present tools and reamers, the job of machining valve seat counterbores in the cylinder head is a tedious and entirely hand-performed operation which takes a machinist approximately 45 minutes to complete on one

head. With the use of the machine being built, a machinist will be able to do all valve seat counterboring on one head in about 10 minutes—a saving of approximately $1.20 per head, it is estimated.

The designer and builder of these machines is Roy A. Thomas, machinist at Riker shop. He is considered by mechanical department officials as a very valuable employee due to his interest in simplifying methods and improving results of jobs performed on diesel parts. Now, let's take a look at some of the special tools developed by other personnel and highlighted in various issues of the B&O MAGAZINE.

Traction Motor Dolly

Some sort of shop truck or dolly is needed for the movement of driving wheel with traction motor assemblies from one shop location to another. Such movement is mainly between the drop pit and machine or traction motor shop where necessary work is performed to restore standard wheel tread contour, etc.

A traction motor dolly with two flanged wheels 12¼-in in diameter and weighing only 146 lb, is in use at the B&O's Riverside shop, Baltimore. When attached to an EMD traction motor weighing 9665 lb, the assembly can be moved along a level track by two men without strain. If movement is over a turntable, four men are needed. The dolly can be attached to the motor by one man in about two to five minutes, and removed in one minute.

Previously a standard B&O dolly weighing 525 lb was used. To attach this device required more than one-half hour's time of a machinist and helper. To push this heavier dolly, motor and wheels, over a turntable, a machinist and helper needed the assistance of a locomotive crane.

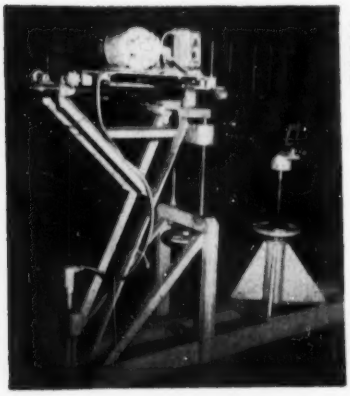
Theodore Rogatchoff, a machinist at Riverside shop, designed and built this very necessary and useful piece of equipment.

Valve Spring Compressor

A tool which greatly facilitates and makes safer one maintenance operation on EMD cylinder heads was designed and built recently at a B&O diesel shop located at Cumberland, Md. This device compresses and firmly holds all four valve springs at the same time, permitting the removal or replacement of the spring keepers which hold valves in place. With this tool there is little chance of fingers being pinched or a piece flying under the considerable force of a suddenly released spring if something slips.

Previously, springs were compressed one at a time by using a lever anchored at one end to a screwed-in adapter. Using this, the operator held down the long end of a lever compressing spring sufficiently to allow for removal or insertion of the spring keepers. A multiple compressor of this type which compressed all four valve springs at once was tried, but several operations were required. Neither the single or multiple compressor of this kind was mounted.

The new tool consists of an inverted screw jack held in a supporting bracket, with a valve spring compressing the plate attached to the end of the screw jack. The tool may be held in a fixed position on a low bench and after a cylinder head has been placed under it, the operator need only turn a crank in order to lower compression plate onto the springs. This device was designed by P. F. Matt, electric supervisor, at this shop.



At left is a special machine for undercutting mica in motor commutators. This too, was designed and built by a Baltimore & Ohio employee.

Another view of the diesel maintenance facilities at the Glenwood shop shows a clean, well-lighted portion typical of other shops on this road.

Injector Nozzle Sleeve Puller

A jig for pulling brass injector nozzle sleeves from Alco diesel engine heads was developed recently by Joseph J. Wojtaszek, assistant foreman, B&O Glenwood shop, Pittsburgh. This pulling jig makes possible the pulling of a sleeve in a fraction of the time required by previous methods, which consisted of removing the head from the engine and driving the sleeve out from the under side of the head.

Mr. Wojtaszek's invention is a jig consisting of a 3¼-in diameter steel hammer head with two handles. It slides on a ⅝-in rod which is welded to a 1-5/16-in 10-thread tap. A soft rubber plug is inserted in the sleeve to prevent cuttings from falling into the cylinder. To pull sleeve out, a workman simply screws the tap into the sleeve and then raises hammer sharply up against head of rod. Machinists using this device are enthusiastic about it too.

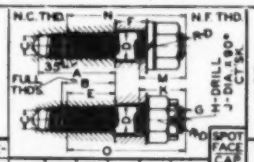
Nut and Bolt Data Sheet as compiled by the Murphy Diesel Company for the convenience of their engineering department. Because of its excellence, permission was obtained to reprint the entire sheet with the idea that it would serve as handy reference to many of our readers.

MURPHY DIESEL

ENGINES POWER UNITS GENERATOR SETS MARINE ENGINES

MECH.-ELEC. UNITS ALTITUDE ENGINES DUAL FUEL ENGINES

MURPHY DIESEL COMPANY MILWAUKEE 10, WISCONSIN U.S.A.



SIZE		TAP DRILL		PITCH DIAMETERS					-NC-NUT-NF-				-NC-HEAD-NF-													
				CLASS 2 FIT		CLASS 3 FIT																				
DIA.	THD	SIZE	DIA.	SCREW	NUT	SCREW	NUT	BASIC DIA.								A B	C E	F G	H J	K M	N O	SPOT FACE CAP SCRS. & N.F. NUTS	OD W T	d L
1/4	20	7	.201	.2175 / .2159	.2175 / .2211	.2175 / .2149	.2175 / .2201	.2175	1/2	.578	1/4	SLOT 3/64 x 3/32	7/16	.505	3/16	11/16 / 13/32	11/64 / 3/8	3/8 / 3/32	3/64 / 3/64	7/16	1 1/32	3/8	.493 / 7/64 / 1/16	1/4 / 1/2
	28	3	.213	.2268 / .2237	.2268 / .2299	.2268 / .2246	.2268 / .2290	.2268	7/16	.505	7/32	HEIGHT 3/32													
5/16	18	F	.257	.2764 / .2723	.2764 / .2805	.2764 / .2734	.2764 / .2794	.2764	19/32	.686	5/16	3/32 x 3/32	1/2	.578	15/64	13/16 / 1/2	7/32 / 15/32	3/8 / 7/64	3/64 / 9/64	1/2	1 1/4	3/8	.591 / 1/4 / 3/64	1/4 / 1/2
	24	I	.272	.2854 / .2821	.2854 / .2887	.2854 / .2830	.2854 / .2878	.2854	1/2	.578	17/64	21/64													
3/8	16	5/16	.313	.3344 / .3299	.3344 / .3389	.3344 / .3312	.3344 / .3376	.3344	11/16	.794	3/8	1/4 x 1/8	9/16	.650	9/32	15/16 / 5/8	9/32 / 5/8	7/16 / 1/8	7/64 / 3/8	13/32	1 1/2	3/4	.688 / 3/64 / 3/32	3/32 / 3/8
	24	Q	.332	.3479 / .3446	.3479 / .3512	.3479 / .3455	.3479 / .3503	.3479	9/16	.650	21/64	13/32													
7/16	14	U	.368	.3911 / .3862	.3911 / .3960	.3911 / .3875	.3911 / .3947	.3911	25/32	.902	7/16	1/8 x 5/32	5/8	.722	21/64	1 3/32 / 23/32	21/64 / 21/32	1/2 / 5/32	7/64 / 3/16	11/16	1 1/2	15/16	.784 / 3/32 / 7/64	3/32 / 3/8
	20	25/64	.391	.4050 / .4014	.4050 / .4086	.4050 / .4024	.4050 / .4076	.4050	5/8	.722	3/8	27/64													
1/2	13	27/64	.422	.4500 / .4448	.4500 / .4552	.4500 / .4463	.4500 / .4537	.4500	7/8	1.011	1/2	5/32 x 5/32	3/4	.866	3/8	1 7/32 / 13/16	23/64 / 2	9/16 / 5/32	9/64 / 7/32	3/4	1 31/32	15/16	.879 / 11/64 / 1/8	1/16 / 3/8
	20	29/64	.453	.4675 / .4639	.4675 / .4711	.4675 / .4649	.4675 / .4701	.4675	3/4	.866	7/16	9/16													
9/16	12	31/64	.484	.5084 / .5028	.5084 / .5140	.5084 / .5044	.5084 / .5124	.5084	15/16	1.083	9/16	5/32 x 3/16	13/16	.938	27/64	1 11/32 / 15/16	7/16 / 27/32	3/8 / 11/64	9/64 / 7/32	13/16	2 3/16	1 1/8	.979 / 3/64 / 9/64	1/16 / 7/8
	18	33/64	.516	.5264 / .5223	.5264 / .5305	.5264 / .5234	.5264 / .5294	.5264	7/8	1.011	31/64	39/64													
5/8	11	17/32	.531	.5660 / .5601	.5660 / .5719	.5660 / .5618	.5660 / .5702	.5660	1 1/16	1.227	5/8	3/16 x 7/32	7/8	1.011	15/32	1 1/2 / 1 1/32	31/64 / 15/16	11/16 / 7/32	9/64 / 7/32	15/16	2 5/32	1 1/4	1.086 / 13/64 / 5/32	1/16 / 7/8
	18	37/64	.578	.5689 / .5648	.5689 / .5930	.5689 / .5659	.5689 / .5919	.5689	15/16	1.083	35/64	23/32													
3/4	10	21/32	.656	.6850 / .6786	.6850 / .6914	.6850 / .6805	.6850 / .6895	.6850	1 1/4	1.444	3/4	3/16 x 1/4	1	1.155	9/16	1 3/4 / 1 7/32	39/64 / 1 1/8	13/16 / 9/32	9/64 / 7/32	1 1/8	2 5/16	1 3/8	1.279 / 13/64 / 3/16	1/16 / 1
	16	11/16	.688	.7094 / .7049	.7094 / .7139	.7094 / .7062	.7094 / .7126	.7094	1 1/16	1.227	41/32	13/16													
7/8	9	49/64	.766	.8028 / .7958	.8028 / .8098	.8028 / .7979	.8028 / .8077	.8028	1 7/16	1.660	7/8	3/16 x 1/4	1 1/8	1.299	21/32	2 1/32 / 1 7/16	23/32 / 1 5/16	13/16 / 5/16	9/64 / 7/32	1 1/4	3 3/8	1 5/16	1.474 / 17/64 / 7/32	1/16 / 1 1/4
	14	13/16	.813	.8286 / .8237	.8286 / .8335	.8286 / .8250	.8286 / .8322	.8286	1 1/4	1.444	49/64	29/32													
	18	13/16	.813	.8389 / .8341	.8389 / .8437	.8389 / .8356	.8389 / .8422	.8389																	
1	8	7/8	.875	.9188 / .9112	.9188 / .9264	.9188 / .9134	.9188 / .9242	.9188	1 3/8	1.877	1	1/4 x 3/16	1 5/16	1.516	3/4	2 3/8 / 1 3/8	13/16 / 1 1/2	1 1/16 / 5/32	9/64 / 1/4	1 3/16	3 7/8 / 3 3/4	1 1/4	1.672 / 19/64 / 1/2	1/16 / 1 3/8
	14	15/16	.938	.9536 / .9487	.9536 / .9585	.9536 / .9500	.9536 / .9572	.9536	1 7/16	1.660	7/8	1													
1 1/8	7	63/64	.984	1.0322 / 1.0237	1.0322 / 1.0407	1.0322 / 1.0263	1.0322 / 1.0381	1.0322	1 13/16	2.093	1 1/8	1/4 x 11/32													
	12	1 3/64	1.047	1.0709 / 1.0653	1.0709 / 1.0765	1.0709 / 1.0669	1.0709 / 1.0749	1.0709	1 5/8	1.877	63/64	1 5/32													
1 1/4	7	1 7/64	1.109	1.1572 / 1.1487	1.1572 / 1.1657	1.1572 / 1.1515	1.1572 / 1.1631	1.1572	2	2.310	1 1/4	5/16 x 3/8													
	12	1 11/64	1.172	1.1959 / 1.1903	1.1959 / 1.2015	1.1959 / 1.1919	1.1959 / 1.1999	1.1959	1 13/16	2.093	1 3/32	1 1/4													
1 1/2	6	1 11/32	1.344	1.3917 / 1.3816	1.3917 / 1.4018	1.3917 / 1.3846	1.3917 / 1.3988	1.3917	2 3/8	2.743	1 1/2	3/8 x 7/16													
	12	1 27/64	1.422	1.4459 / 1.4403	1.4459 / 1.4515	1.4459 / 1.4419	1.4459 / 1.4499	1.4459	2 3/16	2.527	1 5/16	1 1/2													
1 3/4	5	1 35/64	1.547	1.6201 / 1.6085	1.6201 / 1.6317	1.6201 / 1.6119	1.6201 / 1.6283	1.6201	2 3/4	3.176	1 3/4														
2	4 1/2	1 25/32	1.781	1.8557 / 1.8430	1.8557 / 1.8684	1.8557 / 1.8468	1.8557 / 1.8646	1.8557	3 1/8	3.609	2														

STANDARD HIGH NUTS — N.F. THD

SIZE	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1
H	3/8	29/64	17/32	39/64	11/16	45/64	27/32	1	1 5/32	1 5/16
F	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 5/16	1 1/2
W/D	3/64 x 3/32	3/64 x 3/32	1/8	1/8	3/32 x 1/4	3/32 x 1/4	3/32 x 1/4	3/32 x 1/4	3/32 x 1/4	1/4 x 5/16
C	23/64	29/64	33/64	37/64	11/16	21/32	25/32	29/32	1 5/16	1 21/64

STANDARD CENTERS

SHAFT DIA	3/8	1/2	5/8	3/4	7/8	1	1 1/2	2	2 1/2	3	4	5
USE CT'SK HD	D-1	E-1	E-2	F-1	M-1	M-1	N-1	N-1	N-2	N-2		
C	3/16	1/4	5/32	3/8	7/16	1/2	5/8	3/4	15/16	1 3/32	7/8	1
L	11/64	15/64	17/64	21/32	13/32	15/32	23/64	27/64	41/64	51/64	1 1/16	1 1/4
D	3/8	3/8	1/8	5/8	7/8	1/2	1/4	1/4	5/8	5/8	23/32	13/16

AMERICAN STANDARD TAPER PIPE THREADS

SIZE		TAP DR.		PIPE		TIGHT JOINT LGH.	SIZE		TAP DR.		PIPE		TIGHT JOINT LGH.	SIZE		TAP DR.		PIPE		TIGHT JOINT LGH.	SIZE		TAP DR.		PIPE		TIGHT JOINT LGH.
DIA.	THD	DIA.	DEPTH	O.D.	I.D.		DIA.	THD	DIA.	DEPTH	O.D.	I.D.		DIA.	THD	DIA.	DEPTH	O.D.	I.D.		DIA.	THD	DIA.	DEPTH	O.D.	I.D.	
1/8	27	11/32	9/16	.405	.269	1/4	1/2	14	23/32	1 1/16	.840	.622	1/2	1 1/4	11 1/2	1 1/2	1 5/16	1.660	1.380	1 1/16	2 1/2	8	2 5/8		2.875	2.469	1 5/16
1/4	18	7/16	7/8	.540	.364	3/8	3/4	14	15/16	1 1/4	1.050	.824	9/16	1 1/2	11 1/2	1 23/32	1 5/16	1.900	1.610	1 1/16	3	8	3 1/4		3.500	3.068	1
3/8	18	19/32	1	.675	.493	3/8	1	11 1/2	1 5/32	1 5/8	1.315	1.049	11/16	2	11 1/2	2 3/16	1 5/8	2.375	2.067	3/4	3 1/2	8	3 3/4		4.000	3.548	1 1/16

Rigid conection of an I-H distributor unit to the Kiene test pump. Cover serves as catch basin. Commercial accessory kit at right permits attachment to over 250 engine models.

Checking the I-H Fuel Injection System

Kiene's new portable hydraulic test pump broadens the scope of field testing of injection systems. Here, applied to the International-Harvester fuel injection system, is a step-by-step sequence of tests to show what it can do.

"IT'S a test pump with a college education". This statement was overheard in a conversation as being descriptive of Kiene's new test pump. Perhaps this is an exaggeration, but it went through high school anyway. Let's see what it is all about and then go on to see what it can do. Then we will leave it up to you.

Start with a pleasingly streamlined cast aluminum case and cover. You take the cover off, but don't lose track of it—it keeps things clean when the unit is sitting around or being carried from place to place, and is also used as a container. The remainder of the unit contains the pump, its actuating mechanism, and a connector block that houses a 3-way valve, check valve, and provision for gauge mounting. A fuel reservoir with a capacity of over 2½ pints and a micronic-type filter is also incorporated.

One side of the case is recessed. A bar is located flush with the outside contour of the case and lined up with the center of the recess. A handle extends downward into the recess from the pumping rocker lever such that it can be hooked by the fingers of either hand with the heel of that hand resting on the bar. You simply contract your hand to pump, and such is the leverage that it is possible to produce a 5000-psi pressure with relatively little effort.

This pumping arrangment makes the word "portable" mean something; the unit can be used without being clamped or bolted down. With the unit all buttoned up, the bar makes a convenient carrying handle and the whole rig with fuel weighs about 12 to 13 lb. Now it is possible to check a nozzle while it is still on the engine.

If you want to develop sharp pressure waves for some phases of testing, you just clamp the unit to a bench with a "C" clamp, reverse the pumping handle so that it points upward, and hit it sharply with the palm of your hand. Or you can hit the pumping end of the rocker arm with a soft-faced hammer. Incidentally, the rocker arm has two selective pivot points for changing the leverage.

When you pump, fuel is passed through the filter into the pump barrel. The plunger is stainless steel and is closely fitted in a bronze barrel that is supported for its full length by a high-strength sleeve. So, you get the wearing qualities of bronze with adequate strength to prevent distortion under high pressures. Kiene's patented check valves are used throughout.

Once past the positive-sealing check valve, the fuel enters a 3-way valve. In the neutral position both pump and gauge are connected to the outgoing line. In the "up" position, the pump is connected but the gauge isolated, protecting it from pressure shocks. In the "down" position, the pump is isolated, leaving the gauge on the line. This is handy for checking leakage in a system and eliminates possibility of leakage in the tester itself.

A bleeder valve is also provided, whereby pressures in the line under test can be relieved without necessity of breaking any line connections.

Gauges are readily interchangeable as they simply push into a recess in the connector block. Sealing is accomplished by "O" rings. With freedom of the gauge to turn, and the connector block as well, there is movement in two planes to position the gauge for easy reading. Heavy-duty gauges with accuracy to within 1 per cent throughout their range are used. Capacity of the standard tester is over 6000 psi, and a heavy-duty tester runs up to over 9000 psi.

Now the fuel is ready to leave the unit and we come to the matter of "hardwear": the unit must be connected to the item being tested. Adapters and connectors with both rigid and flexible connections are available. The commercial kit, carefully worked out to keep parts to a minimum, provides attachment of the unit to over 250 engines. In the case of International-Harvester, a special kit was worked out for a broad range of field testing.

One special adapter, the nozzle bleeder connection, deserves special mention. It fits the bleeder hole of the nozzle. It incorporates a selective bypass and check valve. With the selector screw threaded in, the adapter is open; when screwed out, one of Kiene's check valves goes to work. Its use will be shown.

The whole rig—pump and all the various attachments—is precision-built but rugged in construction. Materials were selected to provide not only strength but maximum resistance to corrosion. All connectors—anticipating frequent wrenching—are carefully machined and then case-hardened for wear resistance.

This is the equipment: now let's see how it is applied in one of its many applications. Other niceties of the test rig will become apparent in the discussion of its use.

What Can It Do?

First, let's look at this business of testing from International-Harvester's point of view. They have their own fuel injection system which is of the distributor type. Depending upon the number of cylinders being served, either one or two high-pressure metering pumps are used. The illustrations detail its operation.

The system was designed with the idea of maximum unit replacement. If a distributor block leaks, you replace it and are shortly back in business. That's the idea: keep down-time to a minimum. Up until now it was necessary to dismantle the pump or to remove nozzle to diagnose and correct problems. Here is a way that you can diagnose the entire system right on the engine with practically no dismantling necessary.

The latter item can be very important not only from the time and labor point of view, but it minimizes the chance of dirt getting into the system. Dirt and fuel systems don't get along. Even in making the connections to be outlined, all dirt should be removed from the area around the fittings before the system is opened. Then parlay this by keeping the testing equipment clean and by using clean oil.

I-H Fuel Injection System Testing

This sequence of testing has been worked out to give a complete check of the system in logical order and with a minimum of rearrangment of the test equipment. Therefore the order should be followed for maximum advantage. If desirable, however, individual tests can be made.

In all cases where the engine is turned over to perform a test, be sure to rotate it clockwise as viewed from the front end of the engine. Also, if the engine is in running condition it is a good idea to warm it up thoroughly before making any tests.

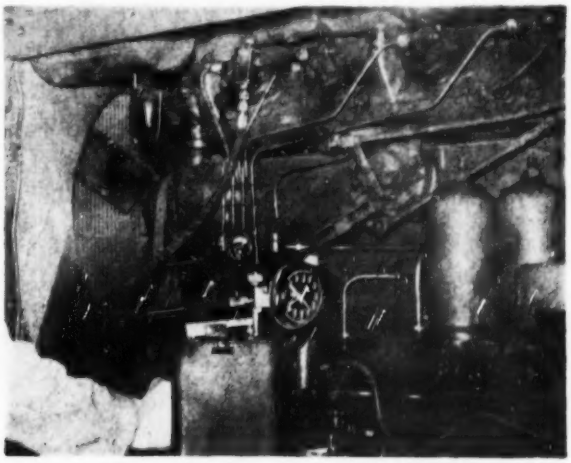
Nozzle Leakage and Opening Pressure Test

a. With engine stopped, remove No. 1 nozzle bleeder screw and connect adapter to bleeder hole.

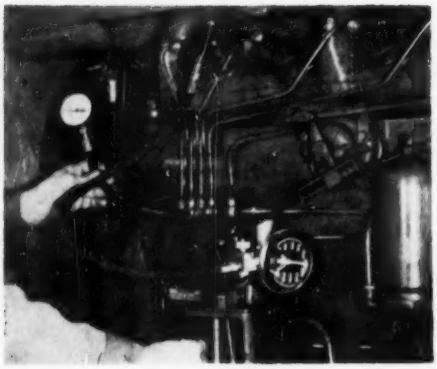
b. Connect test pump with 1000-psi gauge to adapter with the flexible line.

c. Set the adapter to the open position (screw in) and operate test pump until gauge reads 600 psi. If pressure

Complete kit including degree wheel and pointer for analyzing performance of the I-H fuel injection system.



Nozzle Leakage and Opening Pressure Test—Test pump conects to bleeder screw of each nozzle in turn.



COMPARATIVE PRESSURE TEST

INJECTION PRESSURE AT HIGH IDLE P.S.I.

Following are results of representative tests made on the various series engines. As this is a comparative pressure test, the value of the test depends on the difference in pressure between cylinders of the same engine.

Series Engines	Cylinder No.						
	1	2	3	4	5	6	
6, 6A	1350	1350	1400	1400			
9, 9A	1250	1400	1300	1350			
14A	1450	1500	1400	1575			
16	1425	1400	1450	1500	1450	1500	
18A	1500	1450	1525	1525	1475	1525	
24	1700	1650	1650	1675	1650	1675	

Comparative Pressure Test—Injection pressures at high idle are taken at each nozzle in turn. Chart indicates typical readings on different engine models. Low-pressure gauge records primary pump pressure.

drops fast, nozzle valve or distributor valve is leaking. Check distributor valve (as described later on) and if it tests satisfactorily, the nozzle is leaking.

d. To check nozzle opening pressure, keep operating the test pump. The gauge will rise to a certain point and drop. Gauge reading at point just before pressure drops is opening pressure. Record it. It should be between 700-710 psi in a used nozzle and 740-750 psi in a new one. If not within specifications, the nozzle should be serviced or replaced.

Before going to the next nozzle, there is another test to be made with this setup. With the engine running, injection pressures at the nozzle are obtained. Also, primary pump pressure is determined.

Comparative Pressure Test—Primary Pump Pressure

a. Replace the 100-psi gauge with 3000-psi gauge and install 160-psi gauge on plunger unit in place of regular fuel pressure gauge.

b. Set adapter to check valve position (screw out).

c. Record pressure reading on test pump gauge with engine running at high idle. Record for later comparison.

d. Note primary pump pressure as recorded on 160-psi gauge on injection pump. Check filters, bypass valve, and lines for restriction if pressure is low. Pressure should be 58-66 psi.

e. Repeat test on all cylinders.

When these steps have been completed, it is possible to compare the operating pressures at the nozzles. A considerably higher reading on one nozzle is an indication of a restriction in that particular unit that calls for correction. If one is considerably lower than the others, it is indicative of low compression in that cylinder. Better run an engine compression test. See the accompanying chart for typical pressures.

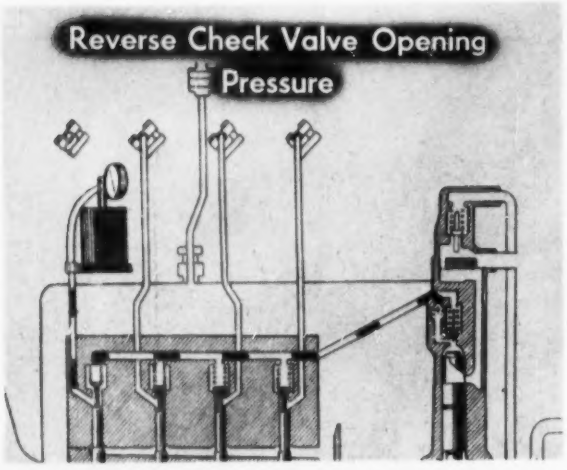
The scope of testing is now broadened to include functions of the injection pump.

Testing Check and Reverse Check Valves

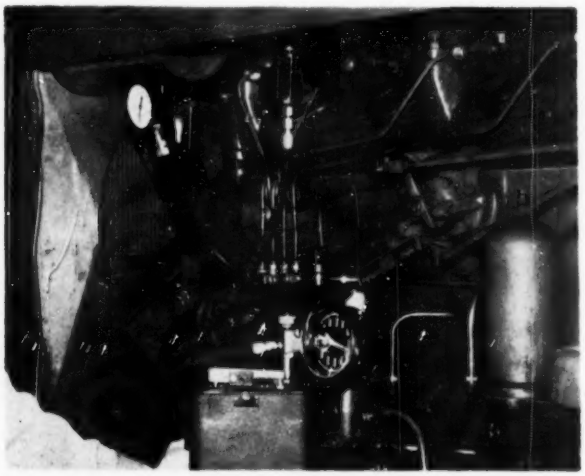
a. Remove No. 1 outlet line from the injection pump. Remove flexible line from adapter and connect to No. 1 outlet of pump. The 3000-psi gauge is replaced by the 1000-psi gauge.

b. Set the control lever in shut-off position.

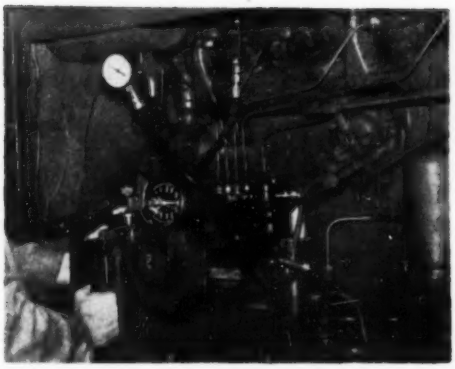
c. See if distributor valve is open by operating test



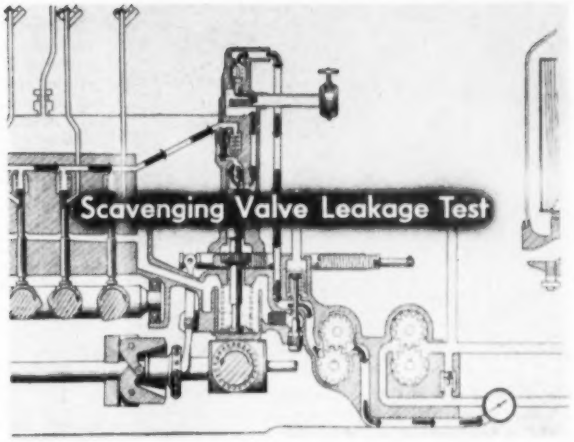
Illustrating the flow of fuel in testing the check and reverse check valves. Drawing also shows details of distributor unit (left) and plunger unit (right).



Testing Check and Reverse Check Valves—Since photo was taken, method of connection was changed to connect test pump to No. 1 outlet line as shown in drawing at left.



Return Check Valve Opening Pressure—Test pump connection used in previous test can be left intact for this and next test. Note drip pipe connection.



Scavenging System Leak Test—Although drawing is labeled "Scavenging Valve Leakage Test", pressurized areas mentioned in text are shown. With engine stopped, scavenging valve blocks leakage passage from distributor unit. Thus, one point of leakage may be past valve into this passage. Low-pressure gauge measures leakage pressure drop.

pump. If the maximum pressure reached is about 500 psi, it is open. If it goes up to the 700-psi range, it is closed. In this case, hold the higher pressure and rotate the engine until it drops, indicating that it has opened.

d. By pump operation, raise gauge pressure to 400 psi and hold it. There should be little or no pressure drop. Pressure drop indicates a leaking check or reverse check valve. Leakage may be due to a weak spring or dirty and worn valves and seats. Replacement or servicing of the plunger unit is necessary. When servicing the unit, inspection will determine whether the check or reverse check valve is the offender and corrective action can be taken.

e. Operate the test pump slowly. The highest gauge pressure that can be reached is the reverse check valve opening pressure. It must open between 450 and 600 psi, preferably closer to 500 psi. It is very important that it does not open below 450 psi. If the opening pressure is too high or too low, it must be corrected.

Fuel Return Check Valve Opening Pressure

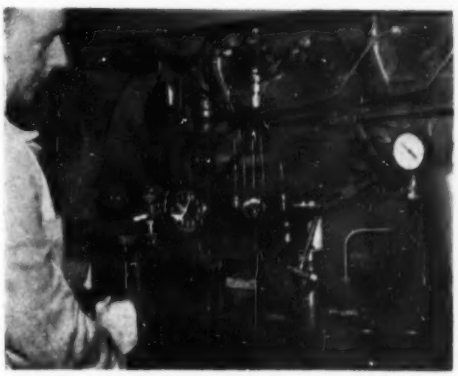
a. Remove the fuel line leading from the final filter to the plunger unit. Install the drip pipe provided in the opening and close the valve on the end thus blocking the opening.

b. With the speed control lever still in the shut-off position, operate the test pump. Opening pressure of the fuel return check valve is read on the 160-psi gauge. It should be around 15 psi higher than the primary pump pressure previously noted.

Note that on twin-plunger pumps the foregoing tests pertaining to the pumping unit and its associated check valves must be repeated on both plunger units. Both reverse check valves should break at the same opening pressure to insure equal plunger loading and fuel line pressure after injection.

Checking Scavenging System for Leakage

a. Replace the 160-psi gauge with the regular unit and remove the fuel line leading from the scavenging pump to the fuel tank.



b. On pumps equipped with a scavenging check valve, remove the molded nylon valve and spring.

c. Install 160-psi gauge in scavenging pump outlet.

d. Operate the test pump until 50 psi is read on the 160-psi gauge. Fast pressure drop indicates leakage of the scavenging valve, bearing cage gasket, primary pump packing, or past the primary pump housing bushing. It will be necessary to remove and inspect these parts and repair or replace them.

Distributor Valve and Stem Leakage Tests

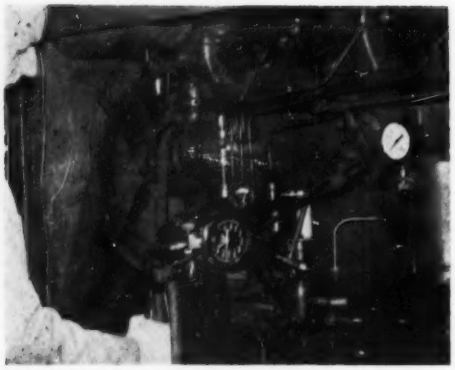
a. Use 3000-psi gauge on test pump.

b. Make sure distributor valve is closed. If open, a pressure bleed-off will be noted at pressures above the opening pressure (450-600 psi) of the reverse check valve. Turn engine until closed.

c. Operate test pump until pressure reading is 2560 psi. Leakage will be indicated by a fast pressure drop.

d. Repeat the procedure on all distributor valves.

When all of the distributor valves have been tested, the results can be correlated with those of the test for nozzle leakage. This will pin down the source of leakage and expedite correction.



Distributor Valve and Stem Leakage Test—Test pump pressure when applied to the top of each distributor valve (when closed) in turn will indicate leakage. It will be signified by a rapid pressure drop

Plunger - Distributor Valve Relationship—Degree wheel is now mounted. Correlation of pressure drops with degree readings permits sequence of events to be checked

Plunger Leakage Test—Pressurized fuel from the test pump leaking past the plunger will flow through the drip pipe (now open) into a graduate for measurement.

Checking Plunger Leakage and Plunger-Distributor Valve Relationship

A degree wheel is part of the Kiene kit for the testing of International-Harvester equipment. Used in conjunction with the test pump, it will be seen to permit check of the relationship between distributor valve opening, plunger port closing, plunger port opening, and distributor valve closing.

a. Connect the test pump to the No. 1 discharge on the injection pump and install the degree wheel and pointer.

b. Make sure that the distributor valve is closed.

c. Operate the test pump until the test pump gauge reads 2500 psi. This pressure will drop gradually, but slowly turn the engine until the pressure drops sharply. Record this as the distributor valve opening point.

Note: *Place speed control in the full speed position.*

d. Continue test pump operation and slow turning of the engine until gauge pressure rises sharply. Record this as the port closing point.

e. Turn engine until injection pump has advanced about 3 deg past the port closing point. With drip pipe in position for fuel downward flow, place container to catch fuel and open the valve.

f. Produce 2500-psi pressure with test pump and maintain for one minute. If plunger leakage is more than 15 cc per min as measured at the container, the plunger should be replaced.

g. Maintaining 2500-psi pressure, turn the engine until the pressure drops off sharply. This is recorded as the plunger port opening point.

h. Continue slow turning of engine and test pump operation. Gauge pressure will rise when injection pump is rotated about 10 deg past the port opening point. Note this as the distributor valve closing point.

i. Check and record data on the plunger unit or units and all their associated distributor valves.

From the data obtained, a definite pattern can be established. It can indicate a worn camshaft or camshaft bearings. If the number of degrees between distributor valve opening and plunger port closing is less than 3 deg. check distributor valves and tappets.

On twin-plunger pumps, the number of degrees between plunger port closing and opening should be the same. This indicates plunger synchronization. Pump rotation between Nos. 1 and 2 plunger unit port closing should be 60 deg and the period of port covering (effective stroke) at any throttle setting should be the same number of degrees. The degrees before TDC that injection begins (port closing) can also be observed and if faulty, it indicates early or late injection.

Summary

By now it is apparent that Kiene's test pump and accessories provide a means of performing what is in effect a test of International-Harvester's fuel injection pump, in addition to nozzzle testing. And done right on the engine!

This newly-developed method of testing takes the guess work out of diagnosing fuel injection system troubles and thus takes full advantage of International-Harvester's design objection of unit replacement of fuel injection system components. These factors reduce to simplification of maintenance and reduction of down-time. Still further reduced, it means cost savings.

Now that you have had a look at Kiene's equipment and what it can do, we'll leave it up to you to give it the proper diploma.

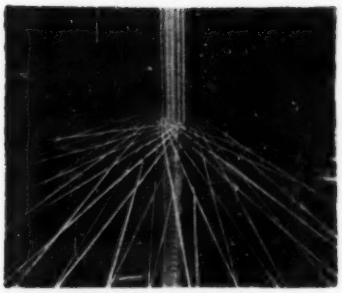


Photo courtesy of Titeflex, Inc.

Fig. 1—Automatic machinery for applying wire braid to metal hose.

Flexible Hoses

WHAT are the types available for different applications

WHY proper selection for your application is important

HOW to get maximum life and utility from flexible hoses

WHAT'S your piping problem? Does vibration bother you, or is it a relative motion? Is it the medium that you are handling, or high-temperature expansion worries? Or perhaps it's a matter of space? Or pressure? Whatever it is, chances are that modern flexible hoses can provide the solution. "Flexible", here, means flexibility as a function and also in application.

In just about every diesel engine installation there is some application of flexible hoses or tubing that will be advantageous. Let's take a look at some of the types available as a prelude to getting into the matter of selection.

Types Stem from Application

The various applications of flexible hose in diesel engine installation have dictated the broad range of types that are currently available. Principal applications include use in fuel oil and lubricating oil lines, cooling systems, starting air piping, and in the intake and exhaust systems. There is also considerable use on driven equipment and accessory items.

What diversity of characteristics is indicated in this brief summary of uses? First, there is the matter of size. Obviously, fuel oil lines would not be as big as intake or exhaust piping. Actually, sizes available run from⅛-in ID to 36-in ID. The larger sizes function chiefly in exhaust and intake piping on the larger engines as expansion joints and to absorb vibration.

Then there is the matter of temperature. Fuel oil and starting air lines will be relatively cold, whereas lube oil lines and certainly the exhaust lines would be hot. Flexible hoses, therefore, are made of a variety of materials including those, such as stainless steel, that have the characteristic of good fatigue strength at high temperature. Their design is such as to accommodate changes of length, due to thermal action, in connected rigid piping.

Pressure of the medium handled is another consideration. It may be a negative pressure as in the case of intake air lines, or a pressure of several hundred pounds as in the case of air starting lines.

The degree and nature of flexibility required also contributes to the diversity of characteristics needed. Hoses may be required simply to isolate vibration and thus avoid the fatigue that would develop in the connected rigid systems. When used to connect up engines mounted on spring or rubber vibration dampers, relative motion may be appreciable.

When used to connect hydraulic or pneumatic control systems, driven equipment, etc., there may be a definite linear motion. Also, the movement might be axial as in the case of a section of hose used as an expansion joint in an exhaust line. In each of these cases there is a difference in magnitude, frequency, and nature of movement.

In some cases, space conditions prompt the use of flexible hose to avoid the complication of rigid pipe fittings. Thus, the allowable bending radius and the possibility of getting clean, gradual sweeps becomes important.

Types for Each Requirement

The flexible hose industry has met all these requirements by providing a sufficient number of types and sizes of hose so that one can be selected to meet just about any combination of requirements. In general, there are three basic types—non-metallic hose; all-metal corrugated hose with or without metal braid; and metallic convoluted hose or tubing sometimes covered with metal braid.

The most popular non-metallic hose is made of seamless, oil-resistant synthetic rubber in which is imbedded cotton braids and a single or double high-tensile steel braid, depending upon the strength requirements. An external impregnated cotton braid or a synthetic rubber cover resists abrasion. If further protection is needed, a metal coil sleeve is added.

These hoses are built in sizes (combining both types) from 3/16-in to 2-in ID. ID sizes are matched to the various sizes of rigid tubing to permit replacement without serious changes in flow characteristics.

The single wire braid type will operate satisfactorily at temperatures ranging from —40°F to 275°F. The top limit is a little lower on the double wire braid type, being 200°F.

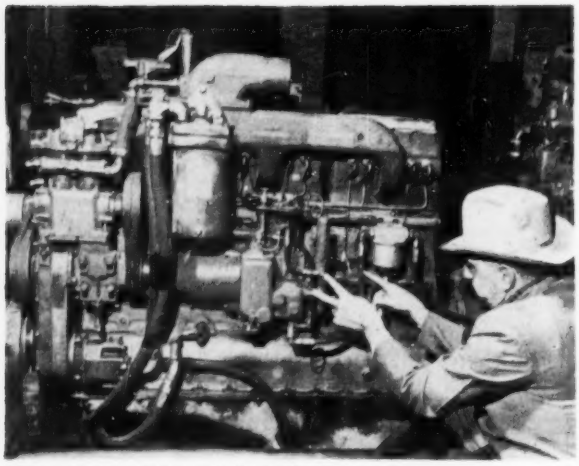


Photo courtesy of Aeroquip Corporation

Fig. 2—Non-metallic flexible hose applied on the fuel and lube oil lines of a Cummins engine. Such an installation eliminates failures due to vibration and extreme temperature.

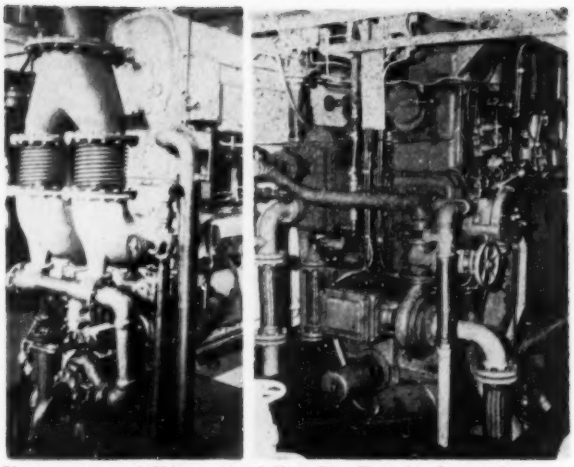


Photo courtesy of Chicago Metal Hose Div. Flexonics Corporation

Fig. 3—At left, helically-corrugated flexible metal hose with flanged ends used as exhaust connectors on a Fairbanks-Morse engine. At right, wire braid-covered corrugated flexible hose used on a Nordberg in marine service. Here it is applied to the fresh and raw water piping, including standby raw water service, and the starting air piping.

Maximum working pressures for these hoses are well within the requirements of the engine systems mentioned; in fact, the lowest (for the largest of the single braid type) is 350 psi. From this pressure they range up to a maximum of 5000 psi. This plus other features to be mentioned later makes them well suited for applications such as the hydraulic systems used on earthmoving equipment, etc.

Most metallic flexible hoses are of the corrugated type having either helical or annular corrugations. Some are constructed from strip material, helically wound and soldered or brazed. Others, particularly for high temperature and pressure applications, are formed from seamless tubing. The pitch or spacing between corrugations and their general shape will affect the bending radius and other characteristics.

In addition to the design, the material used will determine the hose's suitability for certain applications. Materials used range through brass, bronze, steel, galvanized steel, Monel, and the stainless steels. Thus, by careful selection, it is possible to cover the entire range of temperature and pressure characteristics required in diesel application. The highest temperature conditions are normally encountered in exhaust line applications and temperatures in excess of 1000°F can be accommodated. Most high pressure applications involve the smaller hose sizes and in these, working pressures of several thousand pounds can be obtained.

Corrugated hoses can be used bare or may be covered with wire braids. Braid is commonly used in the smaller sizes and is generally available in hose sizes up to roughly 6-in ID. The braids add to the strength of the hose and resist abrasion and other forms of damage.

Another form of metallic hose or tubing is formed from helically interlocking strip material. This convoluted construction makes possible a variety of types to meet a number of applications. The pattern of the interlock varies with manufacturers and also in the types produced by each manufacturer. The interlock may or may not be packed. Cotton cord, asbestos, rubber, and wire are used for packing materials.

Materials used are about the same as for the corrugated hoses. The variety of materials, interlocks, and packing results in a number of types to meet different applications. They are inherently resistant to kinking, friction, and abrasion.

Sizes of the convoluted hose run upward to about 8-in ID. In those built for the higher pressures, working pressures of up to 500 psi can be used. The use of asbestos packing suggests their suitability for high temperature operation; in fact, one of their principal uses is for diesel exhaust lines on buses, trucks, tractors, cranes, and for

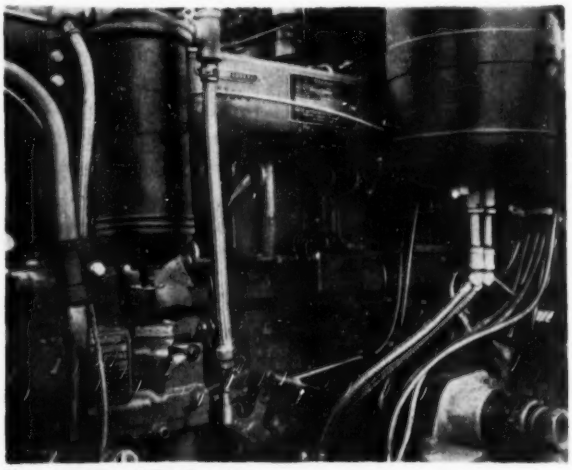


Photo courtesy of Titeflex, Inc.

Fig. 4—Wire braid-covered corrugated flexible hose being connected to oil and fuel filters on the engine. Oil filter is mounted on fire wall and flexibility of hose compensates for movement between it and the engine.

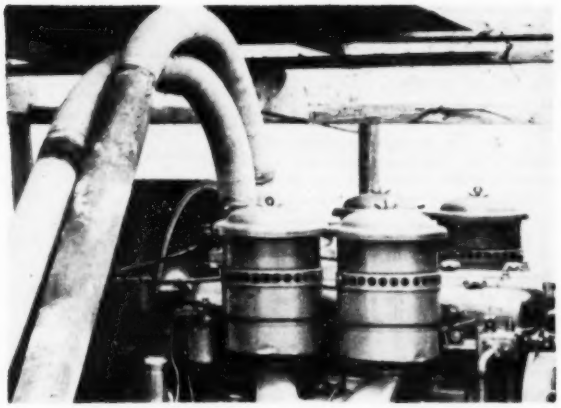


Fig. 5—Convoluted metal flexible hose or tubing used in the exhaust lines of a GM Twin "71". Hose is brazed or welded to connecting flanges or couplings and directly to the rigid pipe in this case.

Fig. 6—Assembly of an exhaust elbow of corrugated metal hose. Welding of flange to hose gives strong leakproof joint and permits high-temperature operation.

Photo courtesy American Metal Hose Branch, American Brass Co.

test block work. One manufacturer, for example, makes an air-jacketed hose for diesel exhausts wherein the inner hose is asbestos-covered and the outer hose so sized as to leave a dead-air space between it and the asbestos.

These hoses or tubes may also be covered with braid for unusual applications. Although naturally resistant to damage from rough handling, greater protection can be afforded by a spiral wire armor.

Hose Assembly Fabrication

Once again, "flexibility" applies to application. Some assemblies are factory-made to fit the specific application. At the other extreme, the synthetic rubber hose and some of the corrugated braid-covered hoses can be made to length in the shop or even on the spot.

Fittings of all kinds can be obtained. Flanges, nipples, couplings, and pipe and tube fittings can all be attached. Welding, brazing, and soldering are commonly used with the all-metal hoses, the process being dictated by the temperature and pressure conditions anticipated. The synthetic rubber hose uses 3-piece, detachable and reusable fittings. Self-sealing, quick-connect couplings can also be attached.

Selection

In planning application, by far the best procedure is to take full advantage of the experience and knowledge of the hose manufacturer. In order to do so, certain information must be supplied to him which in no way differs from that which you must have if you are to make a sensible personal selection.

1. *Application*—What is the specific use of the hose and what is to be handled?

2. *Physical Details*—What are the minimum and maximum ID and OD requirements? What is the length and configuration of the required assembly?

3. *Pressures*—What is the working pressure and the maximum pressure anticipated? Is pressure constant, pulsating, or surging? Is pressure negative or positive?

4. *Temperatures*—What is the average range and the maximum temperature anticipated?

5. *Motion*—What is the nature of motion anticipated? If axial, what is the total movement? If other, what is the amplitude and frequency?

6. *Fittings*—What type of fittings are to be used at each end?

7. *Special Requirements*—Are unusual mounting or motion problems involved? Does the material handled pose any special problem? Is frequency of detachment a factor for consideration?

This data will give a basis for selection so that the hose will have the characteristics to meet the operational requirements. The more complete the data, the better the basis for selection. In Item 7, for example, full details possibly including sketches should be included.

All of the hose manufacturers supply engineering information which, in addition to supplying physical constants pertaining to their various types of hoses, permits calculation of frictional losses at various flow rates. Thus, preliminary hose sizing and material selection can be worked out.

Installation

Flexible hoses have proven their usefulness in any number of rugged applications. However, the best products must be properly and carefully installed in order for them to serve their purpose fully and realize maximum service life.

There is almost complete agreement among the manufacturers of the metallic flexible hoses concerning the major principles to be observed when installing and caring for these products. Even the makers of the non-metallic hoses are in substantial agreement. Therefore the following suggestions, based on years of experience and compiled for users by the Engineering Department of Titeflex, Inc., apply broadly. References to illustrations are to portions of Fig. 9.

1. *Be Sure Hose is Long Enough*—Provide enough length to avoid sharp bends or undue strain at fittings. See that the hose has a "neutral" length (N) at each end of about five times its ID (1A, straight-connected hose; and 1C, loop connection).

Too short a hose in proportion to diameter (1B) will put extra strain on hose near coupling if there is any

vibration. Correct length permits vibrations to taper off to a straight line before ends of couplings are reached.

Loop connections also require accurate determination of length. A controlling factor is the minimum bending distance (illustrated by D in 1C). All manufacturers provide charts giving the minimum bending distance (sometimes expressed as a minimum radius), and means of arriving at the additional length increments such as the neutral length mentioned. In general, the minimum bending distance varies from 40 times the ID for ¼-in hose to 16 times the ID for 2-in hose. Always check with the manufacturer's recommendations, however.

When hose is subject to travel, be sure to add to the above length the amount of greatest travel from the dead mean position. (This is shown by T′ or T″ in 1C) Don't forget that the overall length you order is interpreted as a measurement (L) from face to face of fittings.

A manufacturer of non-metallic hosing calls attention to the effect of pressure on hose assembly length. He states that as much as 6 per cent change in length is possible when the hose is pressurized. It is certainly a good point to consider in length determination regardless of the type of hose.

2. *Install Hose with Fittings Parallel*—Undue strains and twisting are avoided by making sure that the hose flexes in one plane only (2).

3. *Keep Hose Motion in Single Plane*—This plane of motion should run throughout length of hose. Continual twisting of hose outside this plane will cause early fatigue and failure (3).

4. *Avoid Short Radii and S-Bends*—Use longer pipe and 90-deg connections to avoid bad setups such as a short radius (4A), a double bend (4B), and an S-bend (4C). In some cases, on the other hand, it is better to substitute straight connections for 90-deg connections (4D).

5. *Support Hose Securely*—Long runs of hose that flex continuously near fittings because of movement or vibration need support to prevent failure at those points (5A). Support long runs of hose by straps to prevent wire braid creep caused by gravity and vibration. Where chafing is possible, use chafing guards made of rubber, leather, or similar material. Don't make the hose support its own weight by the wrong up-and-over arrangement (5B), and be sure that a support does not cause sharp bends in the hanging hose (5C).

6. *Don't Allow Hose to Carry Any Load*—Hose is designed only for internal flow loads. All pulling or stress-resisting should be left to connecting parts. When the hose connects moving elements, see that the strain is taken up by the supports.

Maintenance Ideas

There are certain practices that may be classified under the headings of "maintenance" although they apply equally during installation and general handling.

1. *Watch Attachment and Detachment*—Don't twist or compress the hose. Twisting causes supporting braid strands to deform or break at fittings. Lacking this rein-

Fig. 7—(a) Spot-solder braid in preparation for cutting by applying flux, heating with iron and then applying solder, rotating tubing to get even surface. Do not overheat tubing.

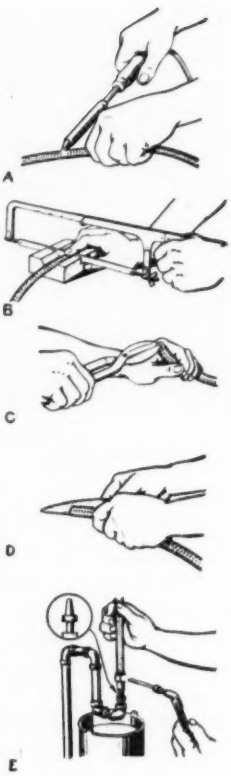
(b) Cut through spot-soldered section with fine-tooth hacksaw or abrasive cut-off wheel. Use vee-block to hold tubing. Do not use power hacksaw.

(c) Trim loose metal strips from ID of tubing using tin snips or any sharp metal-cutting tool.

(d) Deburr end of tubing with a suitable file.

(e) Heat coupling and fill bore two thirds full of solder using enough flux for easy flow. Continue heating, insert tubing over soldering plug and slowly push into coupling rotating until it reaches bottom of cavity. Remove heat and quench.

Note: A soldering stand as shown can be improvised from ½-in pipe. An aluminum soldering plug (insert) is screwed into stand. With stand shape shown, quenching is done by raising pail of water below. Solder should be 50-50 type or equal; flux of zinc chloride or rosin-base (not ammonia). Apply heat to coupling, not tubing.



Drawings and text courtesy Titeflex, Inc.

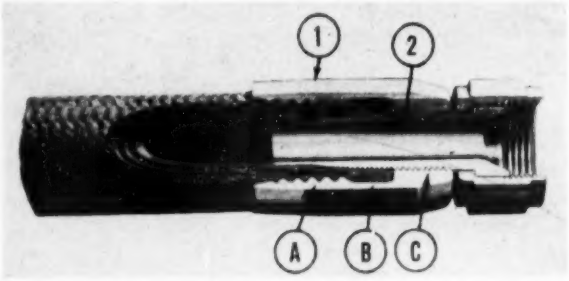


Photo and text courtesy Aeroquip Corporation

Fig. 8—Non-metallic hoses can be made to length from bulk hose and a stock of fittings. Fittings are detachable and reusable and each part can be individually replaced if damaged. Assembly procedure follows:

(a) With hose in vise, cut square to length desired using fine-toothed hacksaw.

(b) Place socket (1) in vise and screw hose counter clockwise into coarse left-hand threads (A) until it bottoms. Back off ¼ turn.

(c) Oil nipple threads (C) liberally and screw nipple (2) clockwise into socket until snug. Swivel ends are similarly applied. Mating adapter and nipple nut are tightened so that adapter hex can be used to screw nipple into place. Leave approximately 1/16-in clearance so the nut will swivel.

Courtesy Titeflex, Inc.

Do's and Don'ts for Hose Installation

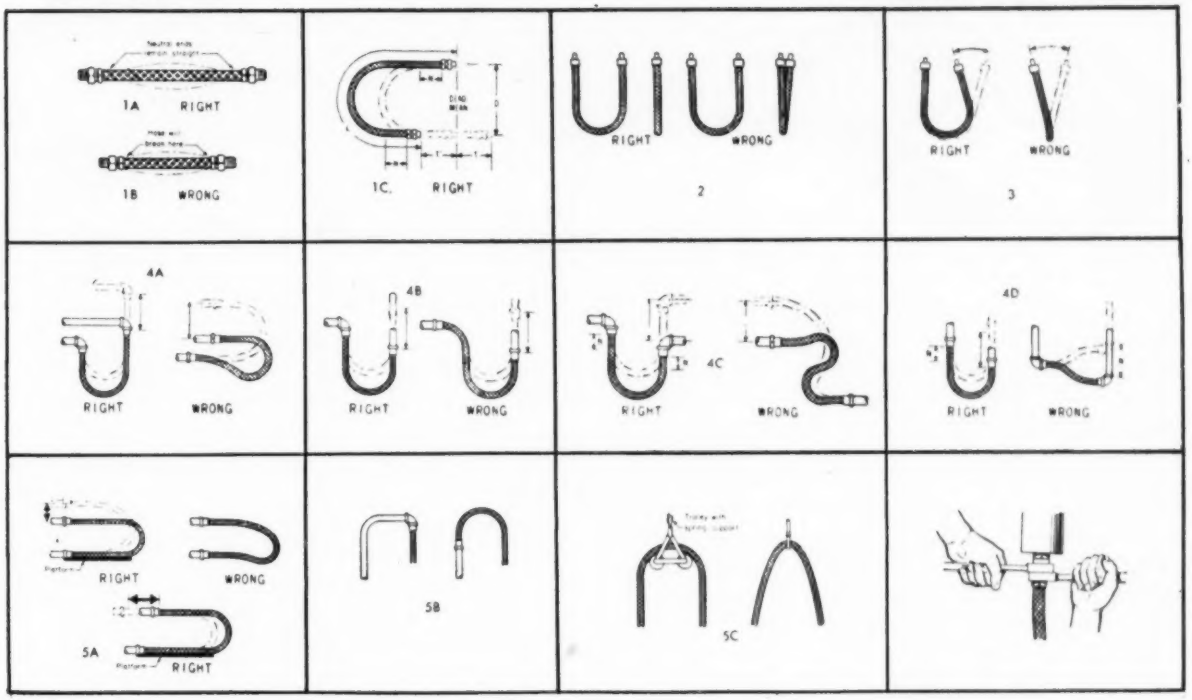


Fig. 9

forcement, there will be early failure. Twisting happens mostly during the installation of a hose having a union connection at one end. You can avoid it by using two wrenches, one to hold the hose in place (as shown in Fig. 9, 6).

Where flanged flexible hose is used, as in an exhaust line, a similar problem is involved in bolt-hole alignment. Don't twist the hose to get alignment; make the adjustment in the extension piping.

2. *Avoid Physical Damage to Hose*—Never stretch hose beyond its elastic limits. It cannot be expected to function properly if permanently elongated or deformed. Avoid crushing or kinking. Long hose lines can be coiled, but care must be taken to insure that they do not kink. The penalty is undue wear of the inner core. When you disconnect one end of a hose, watch out that you don't crush the inner core by too sharp a bend.

3. *Fit Clamp Supports*—Make sure that clamps are the right size for a snug fit. A loose-fitting clamp will allow vibration and cause excessive abrasion, and the opposite condition will crush the inner core. You can insert a soft material between hose and clamp to protect the braid.

When the braid covering breaks or tears, whatever the reason, it's a good sign that you should repair or replace the hose. If the break is near a fitting and the hose is long enough, you can often cut off the damaged section and reapply the fitting.

Conclusion

There is a flexible hose for that particular application you have in mind. First, you must know what is available; next, you can make a sound selection (preferably in consultation with the hose manufacturer); and then you must install and maintain it properly. Then, and only then, can you be sure that you are getting greatest efficiency and life from your flexible hose.

Courtesy of Aeroquip Corporation

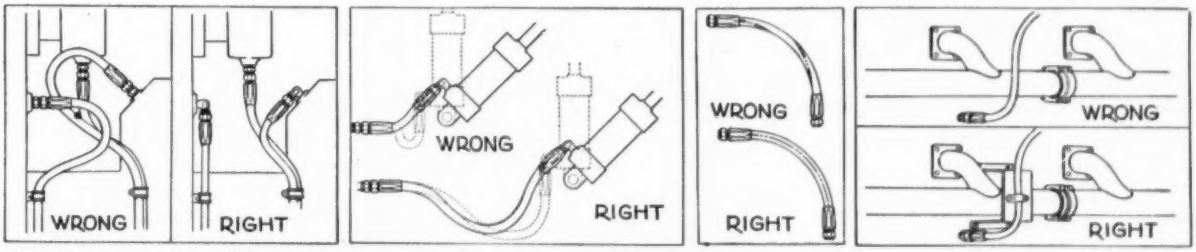


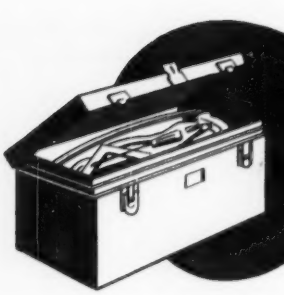
Fig. 10—More Do's and Don'ts.

Elbows and adapters make cleaner installations for easy inspection and maintenance.

With considerable flexing or vibration, leave enough hose length to keep strain off the fittings and adjacent hose.

High pressures in twisted hose may cause failure or loosen fittings.

Hoses should be protected from hot exhaust manifolds by fireproof boot or metal baffle.



Straight from the Tool Box

This is YOUR Department. Pass along your ideas to the other fellow. Send items to the Editor, preferably with a picture or sketch. Contributors will receive $10.00 for each item upon publication.

Sealing Pumps And Cutting Costs

MELVIN B. HILL, PHILADELPHIA, PA.—We have some marine installations of the General Motors Model 567 engines on which trouble has been encountered with the water pumps. Both the fresh and sea water pumps are centrifugal-type units that operate with a positive suction head of water. The pumps are packed with plastic metallic seal rings which we found did a very poor job and were hard to repack when the pump was on the engine. If the packing leaked, the pump would suck air and break the water suction, making the pump air-bound.

We solved this problem by using a different-type seal—a Syntron Shaft Seal #M-42 for a 1-5/16-in shaft. We have had trouble-free service with this type seal for a year or more. Installation of this type of seal requires very little alteration. You have to remove the packing sleeve and packing gland and make a 1/4-in flange to hold the seal in place. The same packing gland bolts are used. Full directions come with the seal and the cost is about $20.

We have also had trouble with water pump shaft wear. The only place that they wear is at the oil and water seals. Replacement is a costly proposition (about $252) and so we worked out a cheaper solution. We now send the shafts out to be metal-sprayed and they come back as good as new. When the shaft wears, we have it sprayed again as there is practically no limit to the number of times it can be done. You get the job done for about $15. We also do this on shafts from our GM 268A's.

Mr. Hill has demonstrated how it is possible to cut maintenance costs and improve performance by ingenuity, knowledge of available equipment, and resort to proven reclamation techniques. It pays off to keep abreast of things—Editor

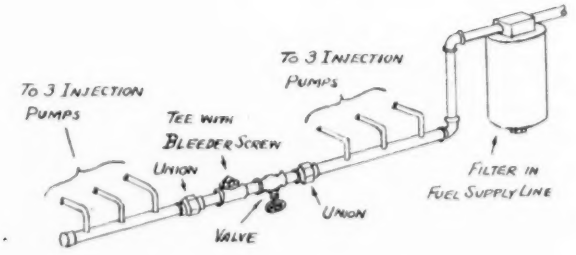
Value And Bleeder Help Avoid Air-Binds

E. SISMEY, MANITOBA, CANADA—We have here two 6-cyl Chicago-Pneumatic diesels. In winter it is important that they are in operating condition almost all the time. Due to heavy power demands from the airport and hospital, our maintenance time is very limited.

We found that the arrangement of the fuel supply system to the injection pumps was not too handy. Feeding fuel from one end of the header, all the pumps became air-bound after the fuel line had been broken for any reason. Cleaning filters, repair work, or replacement on the injection pumps would often have this effect.

We tried to overcome this difficulty to some extent in the interest of saving time in getting an engine back on the line. The idea is simple enough and consists of placing a bleeder and a valve in the center of the fuel header. The section of flexible hose in the center of the header was removed and a length of 3/8-in copper pipe, with a Tee having a bleeder screw and a valve included, was installed by a union at each end.

This arrangement permits isolation of each group of three pumps and permits work on the other section. There can be no drain-back of fuel through an open connection, and thus three pumps are always ready to go. The bleeder



is handy when work has been done ahead of it. Once the engine is rolling over, it is quite simple to get the other three pumps air-free and working again. It saves us time and starting air.

Bleed points are always helpful. Without being on the spot, it is hard to see how the valve setup meets all conditions. However, apparently it has proved helpful so we pass it along. We'd watch that piping like a hawk. That flexible tubing you took out wasn't put in just for grins. Axial freedom for temperature changes may be necessary and vibration may soon cause fatigue failure. Take a look at the article on Page 73—Editor

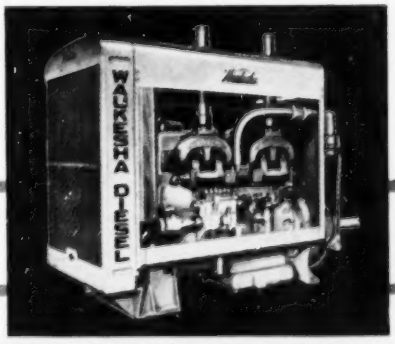
WAUKESHA

1197 cu. in. 6-WAK Series POWER UNITS

WAKU	**Medium Speed, Gasoline**	**206 hp at 1500**
WAKBU	**High Speed, Gasoline**	**255 hp at 1800**
WAKDU	**Normal Diesel**	**212 hp at 1800**
WAKDSU	**Supercharged Diesel**	**325 hp at 1800**

Standard or Counterbalanced Crankshafts

● Super duty! That's what the 6-WAK power units are for . . . and what they do. Here's what they have—every detail built for rough and tumble service . . . crankcase-cylinder block is a deep, thick-wall casting . . . massive, drop-forged, 7-bearing hardened crankshaft . . . pressured oil to every internal bearing, gear, and shaft . . . dual spring overhead valves with Stellite seats . . . cam ground, heavy-duty pistons . . . full-length water jacket, with removable liners . . . and other modern features—for clean burning, high economy, lively performance and long life. Send for Bulletins.



6-WAKDU DIESEL UNIT
6-cylinder, 6¼-in. bore x 6½-in. stroke, 1197 cu. in. displacement.

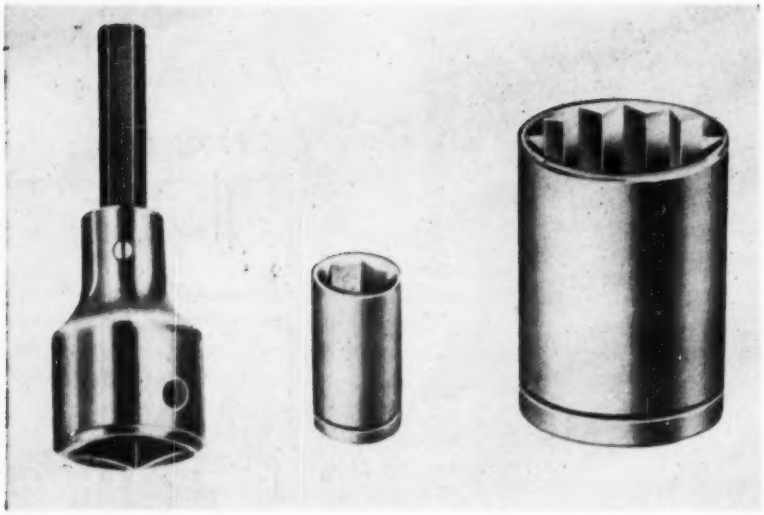
WAUKESHA

Diesels

13 hp to 570 hp

216

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES



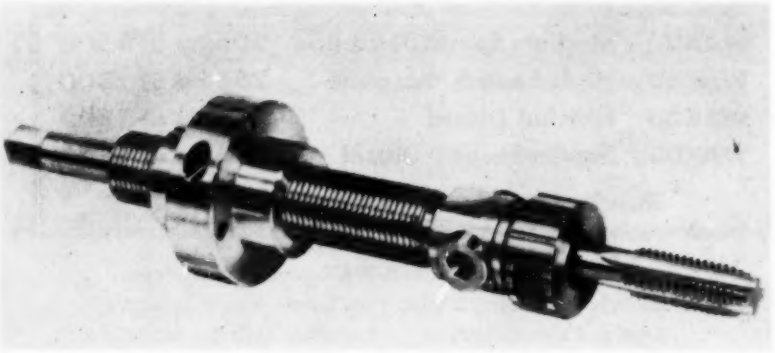
Proto Broadens Line

Two more types of socket wrenches —hollow head screw and metric-size —have been added to the Proto line, it has been announced by J. M. Helferty, Research engineer for the Plomb Tool Company, Los Angeles, California. The Allen head sockets are available in 3/8-in drive with 10 bit sizes ranging from 1/8-in to 3/8-in and accommodating Allen-type screws in the 1/4-in to 3/4-in size range. Metric sockets are available in both 1/4-in and 1/2-in drive in which sizes range from 4 to 12 mm and 12 to 32 mm respectively —nine sizes in 1/4-in and 20 in 1/2-in drive.

Lead Screw

A larger type of lead screw which increases the range of lead screws and "Auto-tap" lead screw tapping attachments has been announced by Automatic Methods, Inc.

Detailed information on the use of "Auto-taps", their size ranges and pitch, is available from Division 85 of the company at 965 West Grand Avenue, Elizabeth, New Jersey.



Precision Gauge

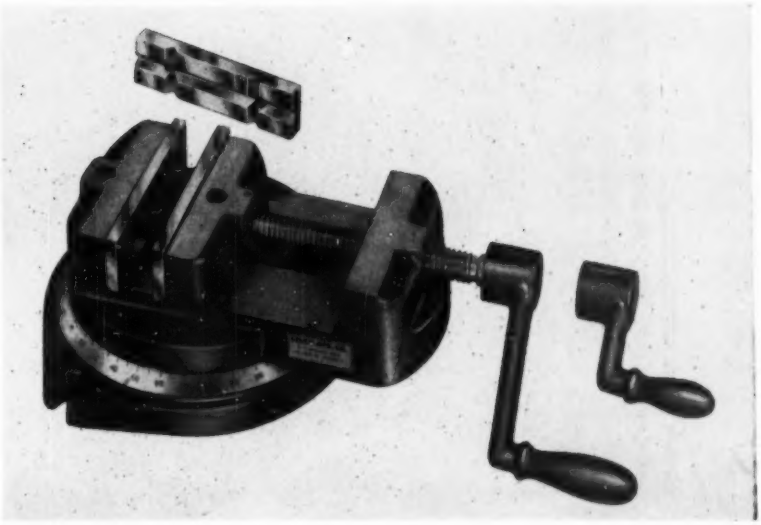
Development of interchangeable gauge heads as a feature of their dial bore gauges has been announced by the Rimat Tool Company. All standard gauge heads for measuring "O" ring grooves, snap ring grooves, pitch diameters of internal threads, small bores and most special gauge heads are now interchangeable on one gauge body.

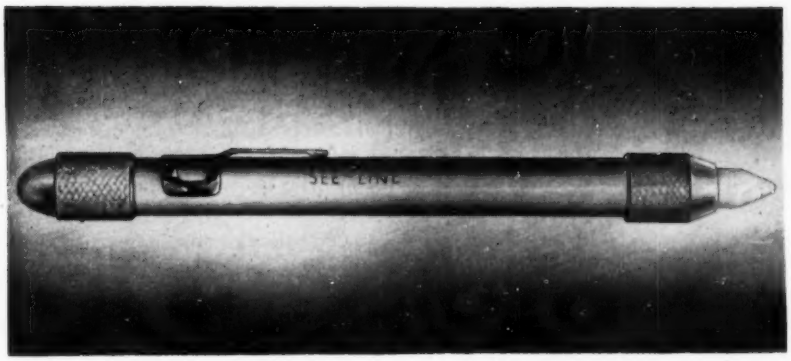
This development brings precision internal gauge costs within the budget of small shops. Further details are available from the company at 21 West Dayton Street, Pasadena 2, California.

PREVIEW

Milling Vises

Production of a 6-in milling vise has recently been announced by the Kenco Manufacturing Company of 5211 Telegraph Road, Los Angeles 22, California. The vises are designed to afford the operator maximum rigidity at all times and also incorporate a vibration-free feature. As an aid in eliminating any possible vibration, the vise body is secured to the base by three bolts located directly below where the work is clamped. The movable jaw is secured by a slide plate and can be locked solid after the work is clamped in position.





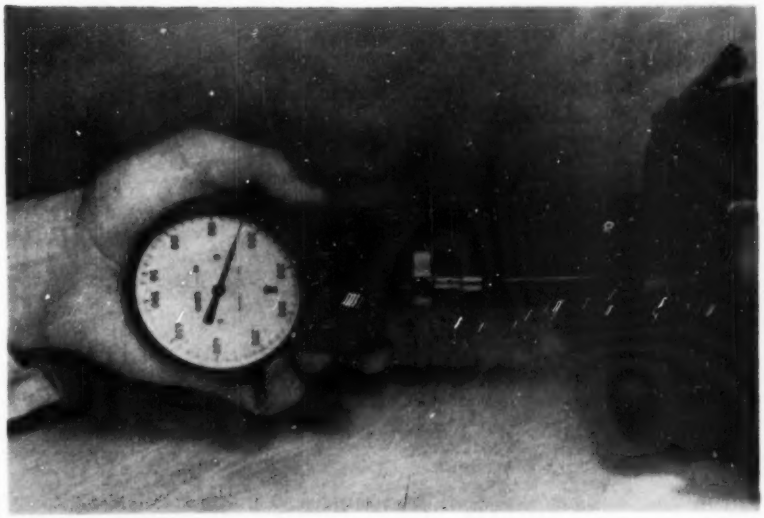
Soapstone Holders

An aid to craftsmen such as welders, plumbers, and metal workers, and those in numerous other trades where metal marking is essential, has been introduced by the See-Line Company. This new tool is a soapstone holder, precision made of machined aluminum. Information available from See-Line, 618 Amarillo Building, Amarillo, Texas.

Tachometer

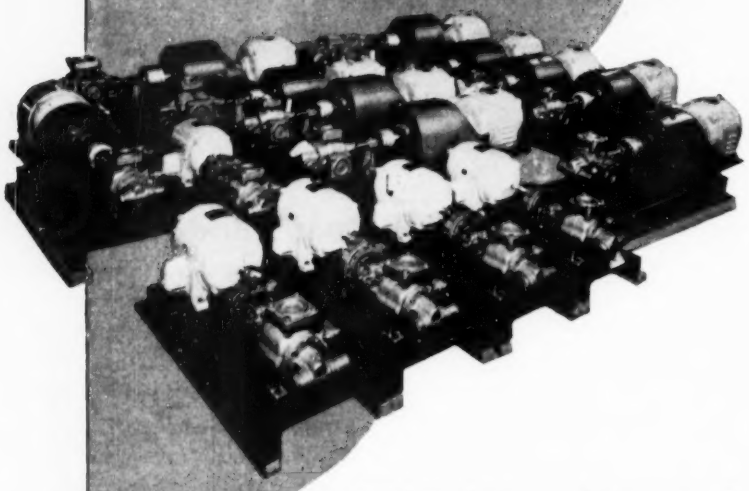
Montgomery and Company Inc., of 53 Park Place, New York 7, New York have introduced a portable tachometer for instantaneously checking the rpm of machinery, revolving shafts, motors, etc. The new hand tachometer registers speeds from 40 rpm to 50,000 rpm and is housed in a metal case.

A rubber tip on the end of the tachometer shaft is provided, and when pressed against the end of a revolving shaft, reads directly on the dial. Further detailed information on the instrument may be obtained from the company.



ROPER

fills a
BIG ORDER...
for a
BIG PROCESSING INSTALLATION



Big order, yes! And the BIG factor that prompted the selection of the fifteen Roper Series 3600 Pumps shown was *dependability*.

Dependability as only painstaking engineering, quality components, and accurate assembly can bring.

Dependability that serves your interests on both long and short runs whether handling thick or thin liquids.

Roper Series 3600 Pumps feature hardened helical gears running in axial hydraulic balance, high lead bronze bearings, split ring packings and split gland, and adjustable relief valve . . . are made in 40 to 300 G.P.M. sizes — pressures to 60 P.S.I. Send today for Catalog 953 giving complete data on Roper pumps, or see your Roper distributor.

ROPER
Rotary Pumps

GEO. D. ROPER CORPORATION
170 BLACKHAWK PARK AVENUE, ROCKFORD, ILLINOIS

Portable Industrial Heater

A complete heating unit with the heat potential of an average furnace and the dimensions of an ordinary orange crate is the new Model E-600 heater, a product of Perfection Stove Co., 7609 Platt Ave., Cleveland 4, Ohio. The unit produce 60,000 Btu's of fresh air output per hour, weighs only 114 lb including the fuel for five hours of service at high speed, and can easily be carried by two men.

Completely self-contained including a centrifugal pressure-type dual blower which separates ventilating air from combustion air while using only one motor, the heater can be operated from 110 v AC or 24 v DC and contains its own power rectifier. Blower is powerful enough to deliver maximum heat through long duct or hose runs without aid of additional fans or blowers. A special non-clog fuel-metering jet maintains steady flow regardless of temperature changes or viscosity of fuel, and positive ignition is assured by a glow plug that vaporizes as well as ignites the fuel.

High-Frequency Pressure Cells

Baldwin - Lima - Hamilton Corp., Philadelphia 42, Pa., announces new high-frequency pressure cells of SR-4 Type HF in five standard capacities: 1000, 2000, 5000, 10,000, and 20,000 psi, with other capacities available. The cells consist of a pressure sensitive tube bonded on the outside with special SR-4 strain gauges.

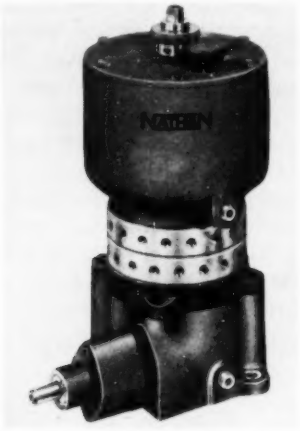
Having no moving parts the cells, in addition to quick response, are claimed to have exceptionally high accuracy and sensitivity. A wide range of temperature compensation is provided to prevent changes of zero and sensitivity (output). Designed for 50 per cent higher output using as high as 25 v, the cells are about 5½-in long, 2-in in diam, and weigh 1 lb.

Impact Power Drive

The new Dril-O-Driver, product of Drilo Corp., 201 E. Carson St., Pittsburgh, Pa., converts all electric drills into speedy impact screw drivers. A "magic connector" furnished with the tool adapts it so that all 54 standard ¼-in drive tool accessories on the market for use with electric drills may be accommodated.

Slow-Flow Lubricator

Nathan Mfg. Corp., 416 E. 106 St., New York 29, N. Y., has developed an automatic precision lubrication system, called the Lo-Flo lubricator, capable of delivering minute quantities of lubricant to as many as 36 individual points regardless of difference in pressures required. Flow rate per feed ranges from 2.3 cu in per hr to less than 1 cu in per 700 hr. Lubricants from light oil to light grease at 60° F may be used and outlets may be manifolded internally to increase flow.



The unit is available with a number of drives. It has self-lubricated construction and is self-priming. Working pressure of 500 psi and 1000 psi relief gives sufficient pressure to overcome line blocks. The lubricator stands less than 14-in high and requires a minimum number of fittings. It can be used with a separate or integral reservoir.

New Pipe Wrench

A wrench with a vise-like grip, which cannot mar chrome pipe, is available from Robert Austin Corp., 51 Albany St., Boston, Mass. Adjustable to accommodate phosphor bronze jawlines to fit pipe dimensions from ½ in to 1¼ in. the wrench also locks in position with a release lever which instantly opens and frees pipe when desired.

A knurled screw adjustment tightens so that the phosphor bronze liners are set in position against inner studs to prevent movement of the liners. Jaws are adaptable for hex inserts to handle nuts and bolts. No change of grip is said to be required for tightening or loosening thread.

Sound Engineering

by

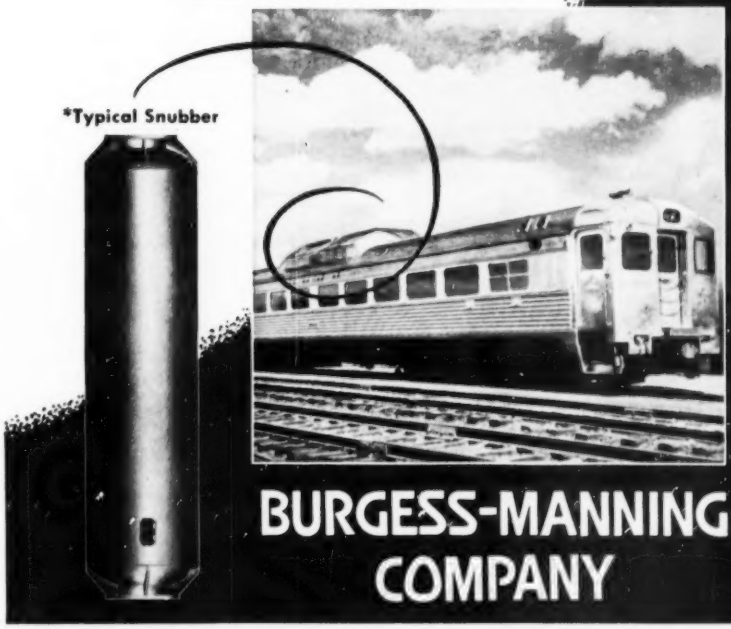
BURGESS-MANNING COMPANY

. . . wherever the flow of AIR, STEAM, and other GASES create N-O-I-S-E.

Standard Snubber* designs are available, incorporating Air Cleaning, Spark Arresting, Water Separation, Waste Heat Recovery, and Surge Control Features.

You can depend upon Burgess-Manning Engineers for a quality product . . . and SOUND ENGINEERING counsel to solve your noise problems.

Burgess-Manning Snubbers installed on The Budd Company RDC Diesel Rail Car.



*Typical Snubber

BURGESS-MANNING COMPANY

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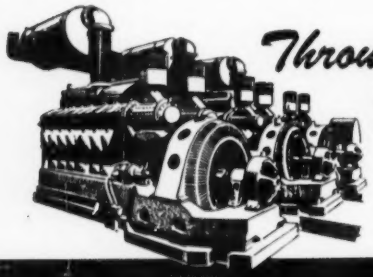
ASK THE AEROFIN MAN

About Practical Heat Exchange

There is a competent Aerofin heat-transfer engineer near you—qualified by intensive training and long experience to find the *right* answer to your own particular heat-exchange problem—and backed by the research and production facilities of the pioneers in light-weight extended surface.

Ask the Aerofin Man.



Throughout the Power Industry—

Aerofin units do the job Better, Faster, Cheaper

AEROFIN CORPORATION 410 South Geddes St. Syracuse 1, N. Y.

Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

Rust-Inhibiting Oil Additive

A new rust-inhibiting oil additive said to offer more complete protection of ferrous surfaces is available in commercial quantities from Atlas Powder Co., Wilmington 99, Del. Identified as Atpet 100, the new inhibitor is a sorbitan mono fatty acid ester, shipped as a concentrate for addition by the refiner or compounder to his oil.

In internal combustion engines particularly, this material is claimed to provide freedom from pre-ignition and other undesirable effects of ashy residue encountered with sulfonic inhibitors containing the salts of such metals as sodium, calcium, or barium. Testing in the company's laboratories indicated consistently uniform protection. It is reported to have withstood 634 hours of exposure at one per cent concentration in oil, or nearly double that obtainable with earlier inhibitors. Superiority is claimed by its behavior in highly refined and treated oils which tend to resist the action of inhibitors.

Coupling for Grooved Pipes

The Gruvajoint is a new lightweight coupling for grooved pipe systems now being produced by Gustin-Bacon Mfg. Co., 210 W. 10 St., Kansas City, Mo. It is designed to save time, weight, freight, and space, in coupling grooved pipe systems where pressures do not exceed 500 psi.

The new coupling is said to automatically absorb expansion and contraction and vibration, to remain leakproof under end pulls up to 7500 lb,

permit misalignment up to 3 deg, and to withstand temperatures between 200 F and —65 F. It can be applied or removed in one minute and may be used over and over again.

New High Pressure Filters

Cuno Engineering Corp., Meriden, Conn., has added high pressure liquid and gas filters manufactured in series 1H and 1HG respectively, to its line of Micro-Klean filters. Standard units are available for operating pressures up to 1000 psi with filters designed for higher pressures available upon request.

Construction is all-welded steel, with the head piece machined from bar stock. Pipe sizes for inlet and outlet connections are ⅜, ½, and ¾ in. Guaranteed degrees of filtration are 10, 25, 50, and 75 microns. Maximum capacity for liquid at 150 SSU, 2 lb pressure drop, and 50 micron degree of filtration is 15 gpm. For gases at 1000 psig, 2 lb pressure drop, and 25 micron degree of filtration, maximum capacity is 200 scfm (free air).

Bracket-Mounting Cord Reel

If you have ever wrestled with a long electric cord when using portable power equipment, Industrial Electrical Works, 1503 Chicago St., Omaha 2, Neb., thinks you will welcome the recently-developed Port-O-Reel. The reel, equipped with a mounting bracket for attachment to equipment, has a built-in collector ring which permits continuous flow of electrical current as the reel is turned.

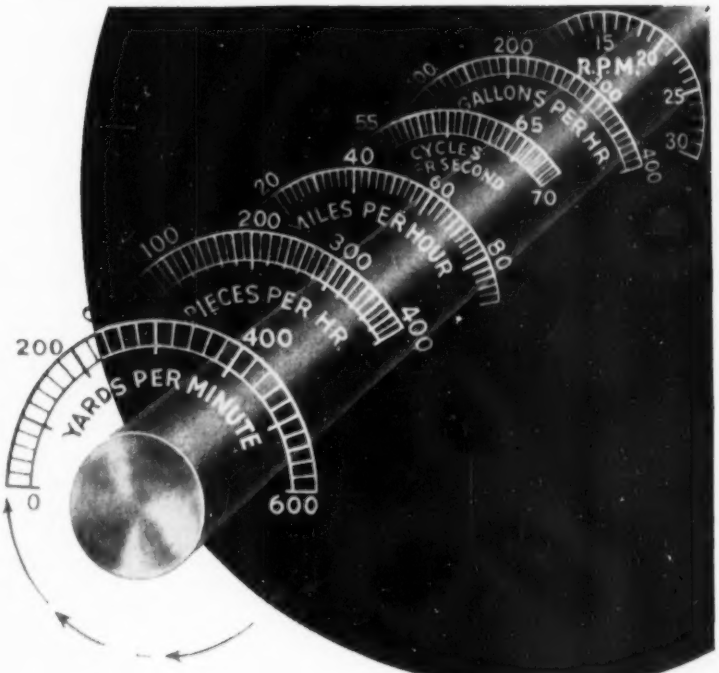
A free-turning knob provides for easy winding and the reel comes with an adjustable brake and lock.

Explosion-Proof Limit Switch

An explosion-proof, heavy-duty precision limit switch, designed for use in explosive gas or vapor-air atmosphere, has been developed by the Micro division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. It is listed as suitable for hazardous locations of Class I, Group C and D.

The switch, smallest explosion-proof snap action unit available according to the company, is made so that the user may adjust the operating head to any of four horizontal positions. Roller arm assembly may be reversed to position actuator roller on either side of actuator arm. Roller arm is field adjustable. Actuator arm assembly is adjustable through 360 deg to any of 870 lock positions at intervals of 0.4 deg.

If some part goes 'round and 'round



...WESTON
Electrical Tachometers

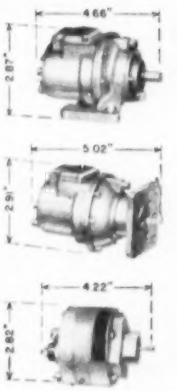
can provide a simple, accurate key to control!

Wherever instant, accurate measurement furnishes the key to precise control, equipment manufacturers now build-in WESTON Electrical Tachometers. For no other method approaches the electrical tachometer for simplicity, ease of installation, overall dependability and ready adaptability to problems of design.

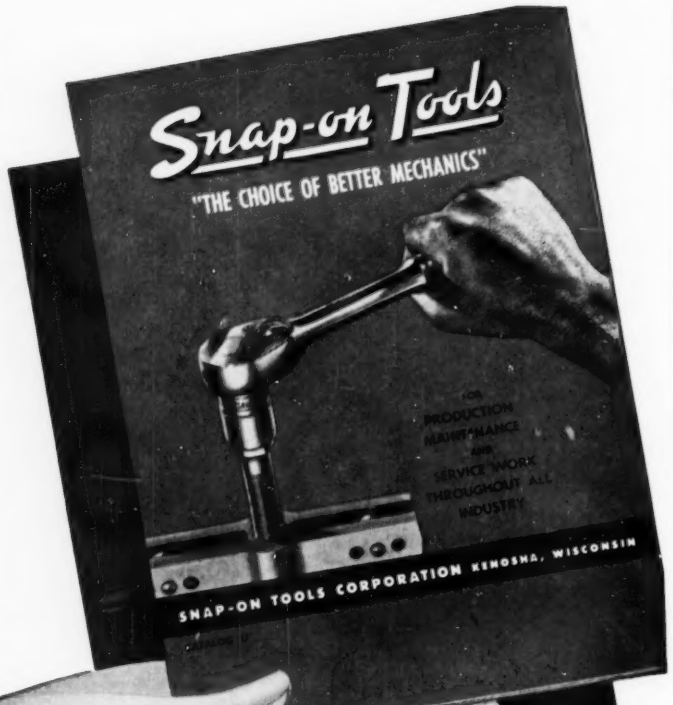
The specially designed WESTON A-C and D-C Tachometer Generators, for example, save up to 50% in size and weight, and are available in forms to permit wide flexibility in mounting, and in connection arrangements. The WESTON Indicators, too, are available in required sizes and shapes, calibrated in any function of the RPM. Available to directly indicate speeds as low as 1/10 RPM up to 80,000 RPM.

Other advantages of electrical tachometers such as . . . multiple indications from one generator . . . remote indications . . . dependable, long-term accuracy . . . and low maintenance, warrant full investigation. Complete details gladly sent on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Space-saving Weight-saving WESTON Generators



WESTON *Instruments*


Snap-on Tools
"THE CHOICE OF BETTER MECHANICS"
FOR PRODUCTION MAINTENANCE AND SERVICE WORK THROUGHOUT ALL INDUSTRY
SNAP-ON TOOLS CORPORATION KENOSHA, WISCONSIN

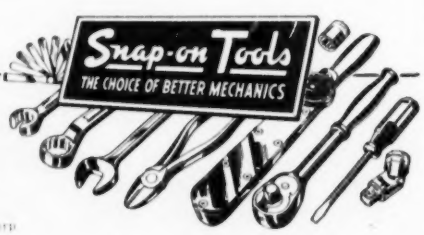
Here's your handy reference book of 4,000 time-saving tools for production and maintenance

NEW

Snap-on* CATALOG

WRITE FOR YOUR COPY TODAY!

You'll want this latest 104-page edition of the most complete, most informative tool catalog published! This catalog lists all sizes and types of wrenches from largest needed on heavy machines to small ones for use on delicate instruments. Special tool equipment for fast repair of diesel and other engines. Includes new tools engineered by Snap-on to help handle difficult jobs with greater speed and safety. Write for your copy today.



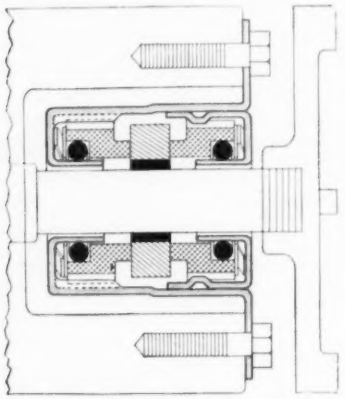
SNAP-ON TOOLS CORPORATION

8064-J 28th Avenue, Kenosha, Wis.

*Snap-on is the Trademark of Snap-on Tools Corp.

Double-Face Shaft Seal

A double-face shaft seal designed to meet the requirements of higher pressures, temperature, and rpm, has been announced by Cartriseal Corp., 3515 W. Touhy Ave., Lincolnwood 45, Ill. According to the manufacturer, the seal provides more positive sealing, requires less space, and is easier to install.



This is a complete unit within itself, with all parts contained in a compact housing cup. Installation is simple; all that is required is to push the cartridge seal onto the shaft and to tighten the mounting screws. Stator rings are designed to insure close hydraulic balance even when pressure is applied from either side of seal. Both stators act as individual seals and are said not to be affected by thermal expansion of companion parts. Cavity between the two stators contains a lubricant that prevents seal from overheating if run dry.

Wire Thread Inserting Tool

Heli-Coil Corp., 1285 Shelter Rock Lane, Danbury, Conn., is producing a new prewinder tool molded of nylon for installation of its wire thread inserts. A lifetime guarantee accompanies tool.

Prewinder thread in tip of tool compresses diameter of wire thread insert and aligns its helix to match helix of tapped threads to be protected. A slotted mandrel with crank handle engages tang on the insert. Turning the handle screws the insert into the nylon prewinder thread and the tapered nose is then placed against the tapped hole. Further turning of handle winds insert into the tapped hole, the tool acting as a thread guide.

Fume Exhaust Hose

The American Ventilating Hose Co., 100 Park Ave., New York 17, N. Y., has introduced a new flexible hose trade-named "Portovent", for fume exhaust and ventilation applications. Made of cotton or nylon and impregnated with neoprene compound and spiral wire reinforced, the product is said to have good lengthwise compressibility and air flow characteristics. It can be cut to size in the field without weakening or raveling because it is bonded and not stitched.

New Pipe Insulation

Gustin-Bacon Mfg. Co., 210 W. 10 St., Kansas City, Mo., announces a new one-piece molded fine glass fiber pipe insulation. Among features of the product are its good thermal efficiency, light weight, flexibility, resiliency, and insolubility in water. It can be cut with a knife and can be painted. It is composed of fine, blown glass fibers bonded with a phenolic resin and molded into one-piece sections 6-ft in length.

High-Watt Ribwound Resistors

Ribwound resistors up to and including 2000 watts are being offered by Milwaukee Resistor Co., 708 W. Virginia St., Milwaukee 4, Wis. They are wound with a specially designed resistance wire on high temperature refractory cores and are said to afford greater wattage dissipation in low resistance values.

All connections are silver-soldered for protection against resistance failure. Coating is high-grade enamel fired at extreme temperatures. The resistors can be furnished as fixed, adjustable, or with multi-taps where desired resistances are known.

Johnson aluminum-on-steel

This new type sleeve bearing was developed primarily for diesel applications... because there is a great need for it. Johnson Aluminum-on-Steel Bearings bring a new set of physical properties suitable for heavy duty, high speeds and high loads up to 5,000 P.S.I. They are rapidly replacing other types in the diesel industry. Aluminum-on-steel has excellent corrosion and fatigue resistance, good conformability and imbeddability, good resistance to shaft wear, and adequate seizure resistance. The aluminum is permanently bonded to the steel backs. They may be furnished plain or flanged, full bearings or half bearings. Let us send you full information. Write today.

JOHNSON BRONZE COMPANY
470 South Mill St. • New Castle, Pa.

JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS:
BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • CAST ALUMINUM ALLOY • LEDALOYL powder metallurgy

JOHNSON JB BEARINGS
Sleeve-Type

New Lathe Chuck

A new addition to the line of lathe chucks made by Westcott Chuck Co., Oneida, N. Y., is the No. 5909, 8-in, 4-jaw independent chuck, threaded 2¼- by 8-in for direct mounting on lathes, milling machines, grinders, and other machine tools with that size spindles. No adapter is said to be required and the chuck is therefore mounted up close to the spindle bearing, to eliminate chatter caused by excessive overhang.

Pressure Reducing Valves

A. W. Cash Valve Mfg. Corp., Decatur 60, Ill., announces a new series of automatic pressure reducing and regulating valves intended primarily for use on Bunker C oil service as well as other dirty liquids or fluids with high viscosity. All sizes are of the direct-acting, single-seated, spring-loaded diaphragm type, which automatically reduces a high pressure to a lower pressure and maintains the lower pressure at a constant.

A new design incorporated in the contour of the piston seat guarantees that the valves will close off well under practically all operating conditions. Working parts are accessible for cleaning or replacement. The valves are available with standard square head adjusting screw, handwheel, or T handle.

Cam-Action Saw Attachment

E-Z Way Tool Co., Barrington, Ill., has developed a cam-action saw attachment to convert the rotary power of an electric drill to a thrust-action saw, eliminating the use of gears. The tool can be attached directly to any heavy-duty drill for cutting of metal or other materials. Each revolution of the power drill is turned into a ⅞-in stroke by the cam action.

Specially designed blades are said to make starting holes unnecessary and the universal chuck will also permit use of any make of hack or keyhole saw blade. The attachment, made of cast aluminum and alloy steel, weighs 3½ lb.

Fire-Retardant Paint

Fyr-Kote Co., a division of Morris Paint & Varnish Co., 27th and Douglas, Omaha, Neb., is manufacturing an oil base, fire-retardant interior flat wall paint that is claimed to stop fire from spreading. When exposed to flame, the paint emits carbon dioxide and calcium chloride which confines fires and delays spread of flame. It is available in white and six colors and is washable.

Portable Flaw Location Kit

Accurate inspection for metal soundness on any metal at any location can now be made through the medium of a new all metal portable kit, Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Cal., announces. The kit can be carried in one hand.

Applied in the field in basically the same manner as in the plant, the materials in the kit indicate cracks as well as porosity and depth of defects. Following pre-cleaning, a red dye is brushed on and after allowing for penetration, excess is removed with a dye remover and followed by a water rinse. White developer is then applied by spray, pulling red penetrant to surface at locations where flaws exist.

It pays to ask that question every time you purchase diesel-powered equipment because the Lanova Combustion System:

- Provides a more economical and effective method of converting raw fuel into useful power.
- Promotes higher combustion efficiencies by thoroughly mixing the fuel with the air needed to support combustion.
- Isolates jarring peak combustion pressures in the Lanova energy cell—feeding them back to the cylinder in the form of smooth, controlled working pressures which are applied to the piston over a full degree of the power stroke.

For the modern, high speed diesel, there's no finer combustion system.

SEND FOR THE INSIDE STORY OF DIESEL ENGINE COMBUSTION

The 58-page Lanova Handbook provides a simple clear-cut explanation of the importance of combustion in the modern high-speed Diesel. Write for a free copy.

Lanova

LANOVA CORPORATION

Dept. 2, 38-15 30th Street, Long Island City 1, N.Y.

One of America's foremost names in diesel research and development

New Literature

New Alcoa Film

"Electrical Wiring with Alcoa Aluminum", is the latest film available from the Aluminum Co. of America, 818 Alcoa Bldg., Pittsburgh 19, Pa. It is designed for the man on the job and deals almost entirely with techniques of handling and joining in installing aluminum conduit, cable, and wire. Accompanying the film is a booklet bearing the same title serving as both a checklist for points explained in the film and a source of information on the characteristics of the aluminum wiring. Requests for the film should be sent to the motion picture division.

Machine Tool Lubrication

The historical development of machine tools, an explanation of their mechanical aspects, and an analysis of the role of lubricants in their maintenance and operation are contained in an illustrated booklet, "Machine Tools and Their Lubrication", which has just been issued by Shell Oil Co., 50 W. 50 St., New York 20, N. Y. It was written to be of interest both to experienced machinists and to those unfamiliar with machine tools.

Hearing Protection

A flip booklet illustrating how noise is controlled by its Lee Sonic Ear-Valv is available to industrial firms from Sigma Engineering Co., 1491 N. Vine St., Los Angeles 28, Cal. Flipping the pages of the booklet animates figures showing how an inner valve is actuated to control harmful noise.

The Ear-Valv is a mechanical instrument of tiny, hand assembled parts. It leaves the ear canal open to air and normal atmospheric conditions, permits hearing of desired sounds without removal of the insert from ears, and takes the harmful sound energy out of loud noises.

Diesel Locomotive Equipment

The Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill., has just released a new bulletin entitled "Pyle Railroad Products for Diesel Locomotives", illustrating and describing the various products available from the company for use on diesel locomotives.

Power Shovels and Cranes

Just released by the Thew Shovel Co., Lorain, Ohio, is a 12-page, 2-color bulletin describing the Lorain "80" Series of power shovels and cranes. The illustrated bulletin covers design and construction with pictures of individual working parts. Among features illustrated are the roller bearing-mounted swing shaft and hoist drum, the hydraulic coupling which prevents shocks and stalling, and the combination third drum and precision boom lowering device for cranes.

Cleaning by Ultrasonic Energy

The Detrex Corp., Detroit 32, Mich., has announced publication of a technical folder on its soniclean process, the application of ultrasonic energy for the cleaning of metal parts. Illustrated by graphs and diagrams, the folder details the principles and methods used in the process which is described as a "properly engineered combination of the solvent degreasing cycle and the application thereto of ultrasonic energy to produce the ultimate in precision metal cleaning".

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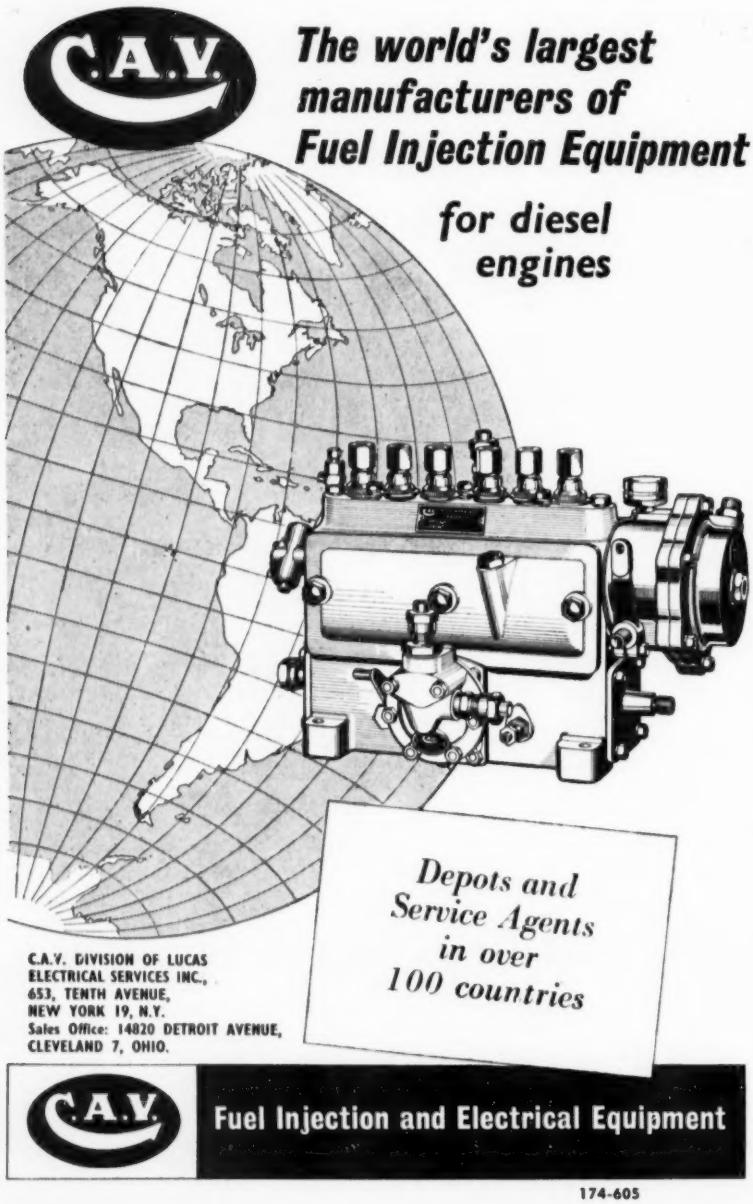
Nickel Alloy Steels Welding

Bulletin A-93, 44 pages, with tables, graphs and illustrations on the welding of nickel alloy steels has been issued by International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. It offers a study of the various welding techniques including some of the newer inert gas processes, electrodes, preheat treatments, and post heat treatments. Typical results that can be expected are given for the low alloy high strength steels, low carbon and medium carbon engineering alloy steels, and special steels.

Corrosion Resistance of Copper

The American Brass Co., Waterbury 20, Conn., has issued a 28-page revised edition of its booklet entitled "Corrosion Resistance of Copper and Copper Alloys", explaining the chemical and physical nature of corrosive attack in its various forms.

Included in the publication is a tabulation indicating the relative corrosion resistance of the principal types of copper and copper base alloys when in contact with 183 different corroding agents. This revised edition also offers more complete information on stress-corrosion cracking, galvanic corrosion, fresh and salt water corrosion. A section has been added on the subject of atmospheric corrosion.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Diesel-Electric Sets

"Power" is the title of a new, 8-page booklet devoted to explaining the use of diesel-electric sets in various types of business and industry, published by Caterpillar Tractor Co., Peoria 8, Ill.

Actual application pictures are used to illustrate the sets including oil, logging, mining, construction, railroad, radio, TV, and other industries. Use of the sets as emergency standby power in hospitals and public utilities is also discussed. Back cover of the booklet contains a chart listing the 12 sizes of the manufacturer's sets available and their rated output for continuous and intermittent use.

Measuring Equipment Catalog

A revised edition of General Electric's 64-page measuring equipment catalog containing information on more than 115 testing and measuring devices for laboratory and production line use, has been announced as available from the company at Schenectady 5, N. Y.

The illustrated publication, GEC-1016A, contains a brief description of each product and its field of application, condensed tables of important characteristics along with prices indicating each device's suitability for specific jobs.

Air Release and Inlet Valve

To describe the functions of their new Type AV combination air release and air inlet valve, a 4-page bulletin, No. 1203, has been prepared by Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia 42, Pa. Pictures of the valve in closed and open operation, general description of the unit, discharge capacities, uses, weights, and dimensions are listed.

New Stainless Steel Movie

A new motion picture "Resistance Welding of Stainless Steel" has just been produced by Allegheny Ludlum Steel Corp., 2020 Oliver Building, Pittsburgh 22, Pa. It discusses spot, seam, projection, and butt welding, is a 16-mm sound and color film, and runs 22 min.

Weld Standards

To enable engineers to acquire both cost and quality control of welding operations, The Lincoln Electric Co., 23801 St. Clair Ave., Cleveland 17, Ohio, has created and is making available a set of weld standards. Based on procedures developed by Lincoln and the weld symbols of the American Welding Soc., the standards are available on tracing paper so that they can be reproduced for the purpose of communicating welding procedure on drawings.

A common problem in designing for welded machines or structures is assuring that the welds specified are made as specified, which is a problem in both communication and cost quality control. The Lincoln standards are said to help solve both aspects, specifying, with a simple letter designation and according to plate thickness, both the type and size of weld as well as how it should be made. With both engineering and shop using the same standards, having prints available at all times, the engineer is assured that the weld he has specified will produce the results designed.

For specified plate thickness, the standards give the electrode type and size, the polarity and current, electrode melt-off rate, arc speed, number of passes or beads, feet of joint welded per hour, and the pounds of electrode required per foot of weld. All factors are specified by using the weld standard designation in conjunction with the regular American Welding Soc. symbol. Standards have been prepared for manual welding of butt welds, fillet welds, lap and corner welds, in all positions in both plate and sheet metal.

Complete sets of 19 sheets on tracing paper in a loose-leaf binder are available for $1 per set, postage prepaid in the United States; $1.50 elsewhere.

Miniature Ball Bearings

Miniature Precision Bearings, Inc., Keene, N. H., has published a 20-page catalog offering latest design and application data on miniature ball bearings in sizes ranging from 0.1-in OD to 0.375-in OD. The technical data is supported by drawings, graphs, tables, and photographs.

Graphic Control Panels

Panellit, Inc., 6312 N. Broadway, Chicago 40, Ill., has released a bulletin entitled "Panelgraphs Throughout Industry". The Panelgraph is a central control panel utilizing visual aid techniques to present process information to the operator. Various techniques of graphic symbolism are illustrated. Also shown are graphic panel components—control devices developed by the company for this phase of process instrumentation. Typical applications are included.

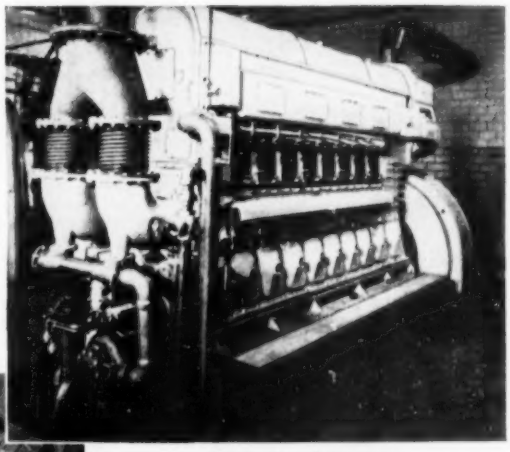
Industrial Jobs for Air Hose

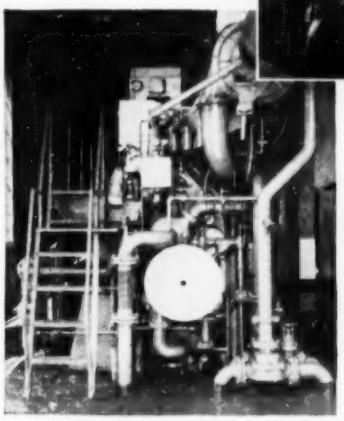
Described in a new bulletin issued by Quaker Rubber Corp., Tacony and Comly Sts., Philadelphia 24, Pa., are a number of different uses for the line of air hose produced by the company. Uses vary from heavy-duty construction, through digging and drilling operations, to many heavy and light industrial and commercial applications. Included are cross-section and cutaway photos as well as performance data, sizes, weights, and working pressures.

WHENEVER rigid piping or ducts must be connected to engines...

CMH Flexible Metal Hose at work on diesel exhaust connectors on a Fairbanks-Morse engine.

Below — at work as coolant water hose on a Nordberg diesel.





HERE'S YOUR GUIDE TO MOTION CONTROL

For helpful information on motion control, Write for Bulletin 124.

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CMH Flexible Metal Hose absorbs engine vibration—isolates the forces that damage rigid piping and loosen exhaust, oil, air and fuel connections. It is also the most economical and dependable method of eliminating piping stresses that result from misalignment or expansion and contraction.

CMH Flexible Metal Hose is available in a wide range of types, sizes and assemblies to meet your needs. Distributors are located in all principal centers. See your classified telephone directory or write for the name of the distributor nearest you.

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Flexonics Corporation

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Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.

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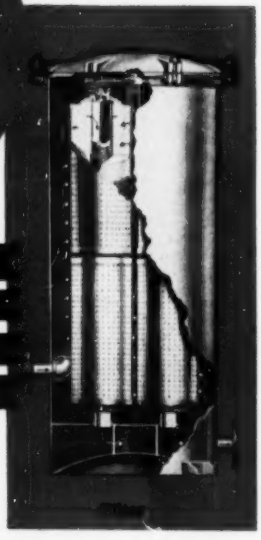

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- *Designed to work with either open or closed cooling systems*
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DETROIT-Controls CORP.

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FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs

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FACTS	EXPLANATION
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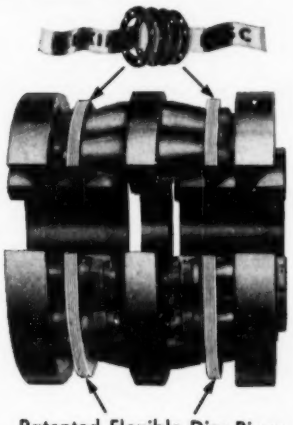
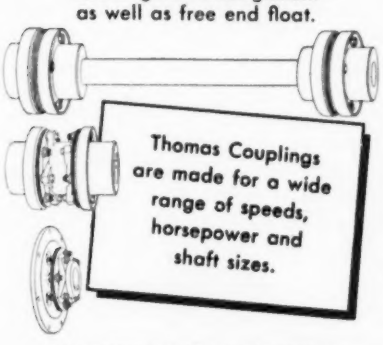
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



Thomas Couplings are made for a wide range of speeds, horsepower and shaft sizes.

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

Electric Generating Plants

D. W. Onan & Sons Inc., has issued a general information booklet concerning the selection of engine-driven electric generating plants. It traces the history of electric plant development from early stages where storage batteries were necessary, to today's modern, single-unit, engine-generator power plants.

Plant operation for each type of plant are thoroughly discussed, AC, DC, and battery charging. The three types of prime mover, gasoline, diesel and gas engines, are reviewed, including cost of operation and installation.

Steel Castings Manual

Comprehensive data detailing applications of steel castings is being made available in booklet form by Steel Founders' Society of America, 920 Midland Bldg., Cleveland 15, Ohio.

Reprinted in manual format, the 16-page illustrated booklet, "Carbon and Low Alloy Steel Castings", includes material covering properties, specifications, design, joining, heat treating, and inspection procedures. A 2-page chart devoted to general engineering types of steel castings, classified according to tensile strengths, is included.

Push-Pull Controls

Arens Controls, Inc., 2017 Greenleaf St., Evanston, Ill., has published a catalog entitled "Guide to the Selection and Application of Arens Push-Pull Controls". The catalog is more of an engineering guide with supplemental catalog sheets and contains engineering data, discussion of factors to consider in planning control applications, together with blueprints and illustrations of various control models available.

Air-Cooled Heat Exchangers

A 12-page, illustrated bulletin on air-cooled heat exchangers for industrial cooling applications has been issued by The Fluor Corp., 2500 S. Atlantic Blvd., Los Angeles 22, Cal. The units described are of the forced draft type and are designed to cool liquids or gases at pressures up to 5000 psi and temperatures as high as 1500°F.

Which of these jobs would you like to do

FASTER, EASIER?

- Cleaning filters
- Desludging lube oil coolers
- Descaling jacket water coolers
- Degreasing parts before repair
- Steam-detergent cleaning
- Plant maintenance cleaning

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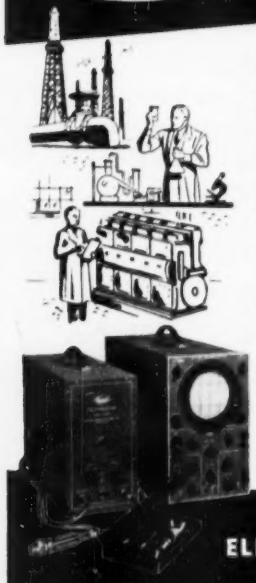

Developing a heavier fuel for economical engine operation . . . or designing a new engine to burn these low-cost fuels? Ask an EPL engineer to show you case history studies where the Pressuregraph provided the answer to proper injection, timing and combustion which resulted in more HP with less fuel consumption and wear.

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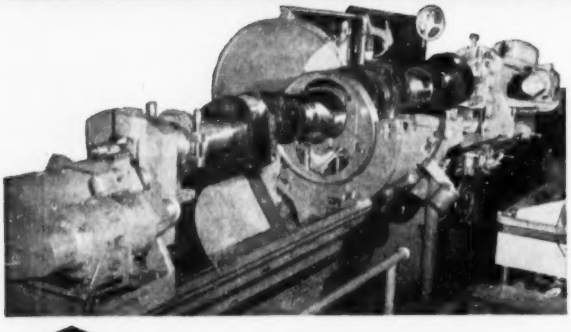

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2929 CANTON ST. DALLAS 1, TEXAS

What Do You Know!

(Answers to questions on Page 47)

1. Correct answer is "b". This valve serves the same approximate purpose as the delivery or discharge valve on fuel pumps such as the American Bosch APE and APF types. For testing of the I-H fuel injection system and drawings showing the system, see the article on Page 68.

2. "c" is correct with "b" as an incidental function. Surges in the supply reservoir, occurring when the plunger uncovers the port at the end of its pressure stroke, are smoothed out by the valve action. For other details see article above.

3. "b" is the correct answer. There are very definite limitations on the allowable bend radii of all types of flexible hoses and usually motion in a single plane will give the best results. For a full discussion on the subject, see Page 73.

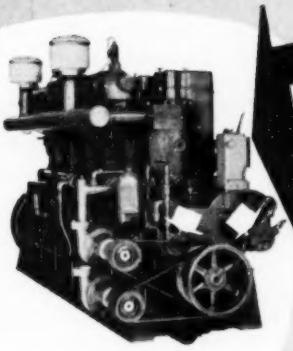
4. Answer is "b". Flexible hoses are only designed for their internal loads and should never carry external loads. See article mentioned above.

5. Functionally, "b" is correct. However, "a" and "c" are also correct and equally pertinent. See the articles on Pages 40 and 58 for examples of step-by-step operation.

6. Correct answer is "a". If one engine picks up too much load, its speed droops and horsepower increases. Thus, the other engine picks up the load until it, in turn, is slowed down. With equal droop, the load is finally evenly divided. With unequal droop, the engine with the least droop will carry the most load. See the article on Page 40.

7. "b" is correct answer. Due to the variety of designs, the tests can differ. For discussion see the article on Page 50 for details.

8. Correct answer is "a". Even defective nozzles can be made to "pop" or "chatter". See the article above.



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For dependable lubrication of diesel engines and power units, Tuthill offers a complete line of positive displacement pumps, designed for lubricating and scavenging. Included are automatic reversing pumps and stripped models for built-in applications.

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Designed specifically for marine engines, S-N gears have these superior features: an exclusive **cone design clutch** with non-metallic lining which creates less heat and gives longer life. It is a type of **wet clutch** which assures proper lubrication of all bearings and working parts; a **balanced reverse gear train** that transmits 100% of the engine's speed and power smoothly; **herringbone reduction gearing** that has more than ample capacity, is rigidly supported on both ends by husky bearings.

ON THE FINEST MARINE ENGINES 4 TO 1000 H.P.

SNOW-NABSTEDT

Transmission Engineers

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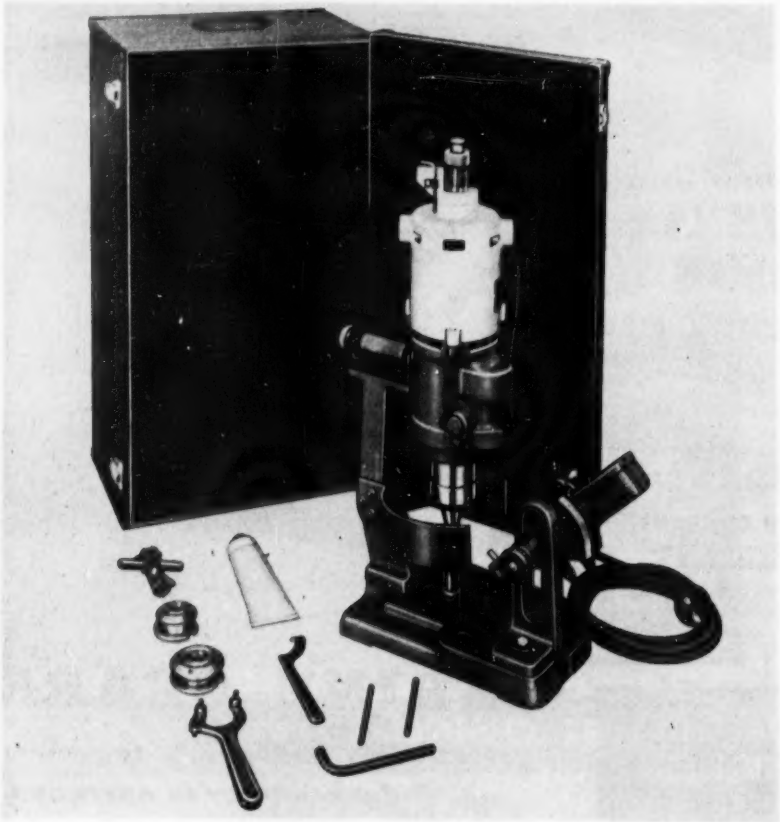
THE SNOW-NABSTEDT GEAR CORP., HAMDEN, CONN.

Field Notes



Eccentric Valve Seat Grinder

Shown here is the Waterbury-Hall Model EDP diesel-type eccentric valve seat grinder employing the patented eccentric "point contact" grinding principle. The grinding wheel, revolving at high speed, moves at 15 rpm in a planetary fashion around the seat. Result is that the grinding action proceeds around the seat, point by point, with the rest of the seat out of contact with the wheel.

A micrometer feed screw permits lowering the grinding wheel into the seat at any desired rate and depth. Minimum amount of material is removed with metal cuttings and abrasive chips escaping freely, thereby permitting faster material removal, better finishes, and longer wheel life, and without danger of wheel grooving. Pilots are available for engine valve guides from 5/16-in to 1¼-in diameter. Grinding wheels are available in all angles, and for all materials, in seats ranging from 2-in to 6½-in diameter.

Governor Rebuilding Plan

Woodward Governor Co. has instituted a governor-replacement plan that arranges for the least possible shutdown time. The plan operates in the following manner.

First, the customer sends Woodward a purchase order for a replacement governor, enclosing the serial number of his present governor. Upon receipt of the order, the company ships the customer a rebuilt governor similar to his but with all the latest improvements included.

The customer keeps the rebuilt governor and on a memo basis is charged full price. The customer then sends his old governor to the company, paying all shipping charges. The company rebuilds the governor, recording time and material costs.

The customer is then issued a credit memo for the same amount billed him on the governor shipped him and a bill is sent him for the cost of rebuilding his old governor.

B&O Installs More RDC's

The Baltimore and Ohio Railroad recently placed a fleet of new Speedliners into operation between Baltimore and Washington, marking the passing of steam locomotives on this run. All trains operated by the road between the two cities will be dieselized and air-conditioned by late October.

The Speedliners, built by the Budd Co., are known as Rail Diesel Cars. Two of the RDC's have been on operation on this run on a trial basis for the past two years. Operating experience and favorable public reaction have resulted in the addition of five new units for the service.

Sebewaing Fights On

In past issues of DIESEL POWER AND DIESEL TRANSPORTATION, editorials have appeared citing a battle which has been raging between the residents of the village of Sebewaing, Mich., and a privately owned electrical utility. The struggle began on Oct. 23, 1952, when a local industry filed a bill of complaint to halt purchase of a diesel engine for the village's municipal power plant.

Legal maneuvers followed. The engine contract has been on and off, first halted by the circuit court, then permitted by the court, and finally halted again following an appeal to the Michigan Supreme Court. Four appeals for modification were made, and recently, an appeal for permission to rent an engine generator was denied.

Meanwhile, energy demands have risen. Yet the village is hamstrung. Under the injunction requested by the local industry, the village is not even able to provide proper maintenance

for the engines presently making up its plant. In order to provide relief for recent lightning damage to the plant, village attorneys have had to appeal to the court.

Sebewaing is a small community that for 40 years has been served exclusively by its own power plant. The residents preferred that arrangement. When more power was needed, the village council, with the approval of the Defense Electric Administration, contracted for a diesel generator.

A private utility which serves adjacent areas to the community, and with which the village power plant has never competed, decided it wanted to sell the village its power. After various unsuccessful attempts to influence the residents, and with no request from the village to do so, the utility built a substation outside village limits and connected it to its private system by means of a transmission line.

Village attorneys, in their fourth appeal to the court, stated that although the lawsuit was brought by the local industry, the real interest in the litigation is the utility, "which seeks by this means, having failed by a direct method, to sell electric energy to the village . . . "

The case has been before the Supreme Court since January 13, 1953. A new petition recently filed by residents asks that the village be permitted to take temporary measures to meet the power emergency. It states that "over 75 per cent of the people in the village of Sebewaing" commend the village council's action in purchasing the new engine.

It further states that the court action was brought to compel them to purchase power from the utility and that the local industry which filed the complaint "had knowledge of the power situation" and the action taken by the village council to give the plaintiff assurance "that adequate power will be available at all times for its use."

The court has to decide whether a corporation has the right to purchase additional equipment to meet demands, through power of its board of directors (in this case the village council), without mortgaging all its clear and paid-for holdings. This issue arises from the action of the village council which ordered purchase of the engine without placing any obligation upon the power users, except the payment of regular rates charged.

Sebewaing citizens point out that their power plant is a profit-making corporation having two aims. First, it seeks to maintain adequate equipment to fulfil its public trust. Second, it seeks to build a suitable sinking fund and to return additional profits to its customers through lower electric rates.

Final decision of the Michigan Supreme Court is being anxiously awaited by Sebewaing as well as other communities which own their own power plants. This will determine whether citizens have the democratic right to choose their own power sources or be forced to accept purchased (and higher cost) power.

Diesel Operators Institute

For the benefit of men who operate or supervise the operation of diesel power plants in Nebraska, South Da-

here's why it's needed

Overheated jacket cooling water or lubricating oil pressure failure can develop anytime . . . and it can happen to the best engine! When this happens, serious engine damage will occur. To prevent such costly damage, engines need the protection given by PENN Safety Controls.

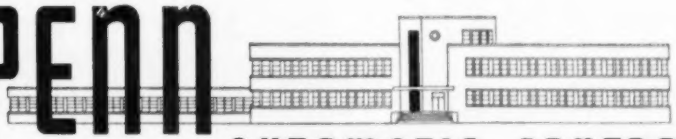
a "MUST" for your engines

here's how it works

If water temperature rises beyond the predetermined safe point . . . or if oil pressure falls too low . . . the PENN Safety Control goes into action. It automatically sounds an alarm, flashes a warning light or stops engine operation . . . whichever you choose. Then, the fault can be investigated and corrected before serious damage develops.

Learn more about this *low-cost* protection for *new and old engines.* Write **Penn Controls, Inc., Goshen, Indiana.** Export Division: 13 E. 40th Street, New York 16, N. Y., U. S. A. In Canada: Penn Controls Limited, Toronto, Ont.

PENN



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FOR HEATING, REFRIGERATION, AIR CONDITIONING, GAS APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

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Absolute uniformity of wall thickness . . . no seams or packed joints . . . absolutely tight against water, oil, steam, gas, air . . . dampens vibration . . . . maintains flexibility at extremely high temperatures.

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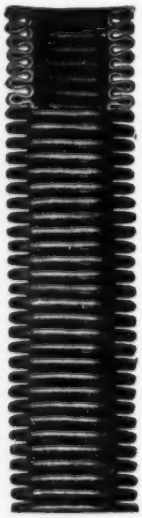

Diesel Bulletins 1020 & 50A furnish complete information.

See our Catalogs in Sweet's Files for Product Designers and Mechanical Industries.

ATLANTIC
METAL HOSE CO., INC.
109 West 64th St.,
New York 23, N. Y.

kota, and Kansas, the University of Nebraska is presenting a Diesel Operators Institute, Oct. 15, 16, and 17.

Panel discussions include: proper usage of fuels and lubricants; maintenance of fuel injection equipment; preventive maintenance; relative economy of oil vs. dual-fuel engines; problems in operation of dual-fuel engines; operating records and costs; and bearing failures and bearing maintenance.

CPR Orders Four RDC's

Canadian Pacific Railway Co. has ordered four self-propelled rail diesel cars from the Budd Co. for three separate operations in eastern Canada. This is the first order to be made by a Canadian railway following extensive studies and a trial operation of a demonstrator car on the mountain run between Montreal and Mont Laurier last February.

Three of the cars are RDC-1's and one is an RDC-3. Delivery is expected in November. They are powered by two 275-hp GM diesel engines, located beneath the floor, and driven by torque converters fixed to one axle of either truck. From a standing start they can reach a speed of 44 mph within 1 min and can attain a top speed of 85 mph.

Customer Seminars

Van der Horst Corp. has instituted a series of customer seminars with the purpose of bringing the customer to the scene of operation where he can see at first hand how Porus-Krome and Vanderloy are produced and how they are used. Each seminar lasts two days and includes only one customer at a time.

The Pennsylvania Railroad was the first to take advantage of the meetings and the next one on the docket is the New York Central. Invitations are being sent to other railroads, engine builders, and other customers of the company.

The first day of the session is devoted to a review of the electroplating principles of Porus-Krome and Vanderloy; a tour of the laboratory where the physical metallurgy of chromium and Vanderloy and the control methods employed in electroplating are

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demonstrated; and a tour of one of the plants with a step-by-step study of the Vanderloy process in production.

The second day of the seminar includes a tour of another plant with a step-by-step study of Porus-Krome process in production, and a classroom session. The classroom session involves: demonstrations of the use of inspectroscope, dial bore gauge and micrometers; illustrations of defects to be looked for in a cylinder liner both before and after plating; design of plating fixtures and their relationship to quality chrome plating; and a showing of the motion picture "Cradle of the Giant."

Iron Ore From Nickel Ores

The International Nickel Co. of Canada, Ltd., announces that it is undertaking production of byproduct iron ore from nickel ores in the Sudbury district of Ontario. The company is beginning construction of a $16 million plant as the first unit in an operation which will yield about 1 million tons of high-grade iron ore a year in addition to nickel.

Alcoa's Aluminum Skyscraper

Pittsburgh's skyline is now enriched by a 410-ft structure, the lightest building for its size ever built. It is the Alcoa Building, 25 floors of the 30-story structure being occupied by the Aluminum Co. of America, with the balance rented to other tenants.

Alcoa is practicing what it has preached about the practicability and excellent characteristics of aluminum for a wide variety of uses. It enables them rightly to claim more building innovations than any other structure of modern times.

Exterior walls sheeted with hundreds of aluminum panels and reversible completely weather-tight aluminum windows are only two featured uses. Utilizing the excellent heat transfer characteristics of aluminum, the material is used for heating and cooling the air-conditioned rooms in the form of aluminum ceilings, piping, and ducting. A roof-top aluminum cooling tower, the largest of its type ever constructed, cools conductor water for the air-conditioning refrigeration equipment.

Wide use is made of aluminum for lighting fixtures, elevator cabs, partition framing, and the miles of interior trim. Many thousands of pounds in weight are saved.

Alcoa's promotion of the use of aluminum for electrical conduction is exemplified in the switchboard and distribution carriers throughout the building. Specially designed low reactance buses of the sector type are built up of aluminum extrusions. Aluminum taps to power and light switchboards complete the distribution circuits.

Alcoa has demonstrated that its pro-

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Please print name and address and give P. O. ZONE number.

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RR Fuel Buys Bare Diesel Trend

The trend toward dieselization of the nation's railroads was reflected in increased consumption of diesel oil by the railroads once again in 1952, according to a report presented at the annual meeting of the purchases and stores division of the Association of American Railroads by A. W. Hix of the Chesapeake and Ohio Railway.

Locomotive diesel oil consumption in 1952 was 16.6 per cent greater than in 1951, and five times above that of 1946, it was revealed. Last year the railroads used 2,671,429,925 gal of diesel oil for fuel and 1,472,609,421 gal of heavy fuel oil, the second straight year in which consumption of heavy fuel oil fell below that of diesel oil. The use of fuel oil was 26.8 per cent less than that of 1951 and fuel coal consumed was 32 per cent under 1951.

Bearing Development

The General Electric Co. has developed a new traction motor suspension bearing that "will enable more than 90 per cent of the locomotives so equipped to operate between monthly inspections without addition of oil to the axle caps."

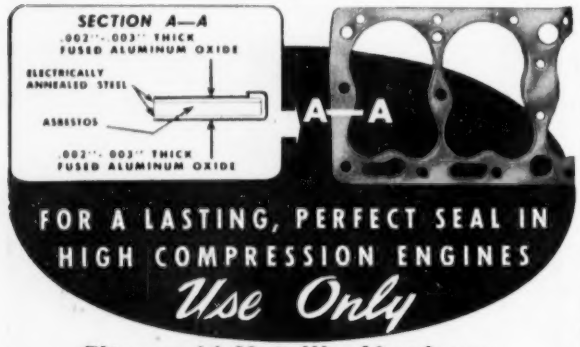
A two-year development program to overcome a deficiency in bearing lubrication has resulted in radically reducing oil consumption, according to G. W. Wilson, general manager of the company's locomotive and car equipment department. Factory testing of various designs indicated that the correct approach to better oil mileage was not to supply a minimum of oil to the journal, but rather to supply as much as possible and return the excess to the cap. Oil return grooves in the lining are the crux of the new bearing. They represent the outgrowth of tests.

Extensive field testing was carried on for 18 months to find the best oil-return type of bearing. Oil level *vs.* mileage was measured on a total of 26 locomotives on 11 different railroads, with the result that the new bearing "consistently showed that any type of service locomotives so equipped can run three times longer between oilings." Mr. Wilson points out that the design is such that railroads can obtain the same benefits by modifying old bearing linings.

Bosch Licenses British Firm

Simms Motor Units, Ltd., London, England, has been granted the British manufacturing rights for certain American Bosch diesel fuel injection equipment, it was recently announced. Under terms of the agreement, Simms is permitted to produce all new types and sizes of injection pumps and nozzles in the diesel line of the American Bosch Corp. It is said that a small injection pump of the distributor type is the principal product currently being considered for manufacture in England.

The distributor-type injection pump



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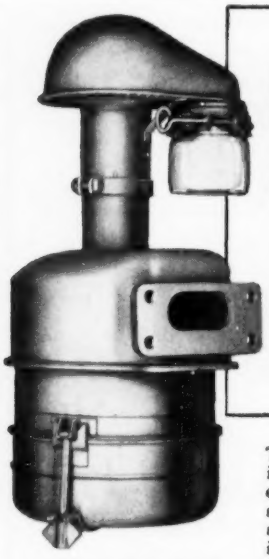

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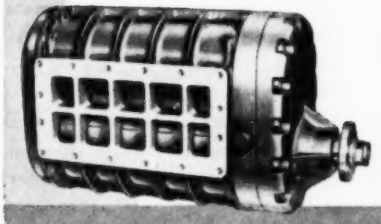

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was designed and developed several years ago by American Bosch to provide a lower cost, lighter weight, simplified injection system for diesel engines. Introduction of this pump is said to have contributed to the development of small diesel engines for farm machinery and other uses. The agreement between the two companies also calls for exchange of technical information and know-how.

RRs Study Passenger Car Design

The New York Central and the Chesapeake and Ohio announced recently that they have entered into a joint arrangement looking forward to the building of passenger-carrying cars of lighter weight and lower cost for operation on their respective railroads.

Both carriers regard this program of pooled research on equipment design as one of the important approaches to the solution of the passenger traffic problem. They believe that this is also an important approach to winning back travel markets which continue to be lost to competing forms of transportation. Arrangement calls for conducting the project on an equal partnership basis, taking full advantage of the engineering skill and experience available not only in the two companies but also among the leading manufacturers of railway passenger equipment.

Diesel Stretches Hauler Output

The installation of diesel power in a hauling unit used to transport sand and gravel from pit to washer has almost doubled the daily output of the Glacier Sand and Gravel Co. of Cowansville, Pa., it is reported. A 3-cyl diesel engine was installed in a model W 55 Koehring Dumptor, in Oct. 1951. After 18 months of operation, figures showing the performance of the unit were totaled and reflected the increased efficiency the diesel brought to the equipment.

According to C. H. and Elmer Snyder, owners of the plant, the old-engined unit averaged 13 round trips per hr moving 5½ to 6 tons of material per trip. The power plant consumed 2 gal of fuel per hr and required overhaul every 11 mo. After the diesel installation, round trips increased to 20 per hr while the amount of fuel consumed for the same period decreased 50 per cent. And after the 18 months of operation, there were no indications that the engine needed repairs of any kind.

The Snyders started their operation in 1949 with a daily output of 500 tons. Currently their daily production has stepped up to about 1000 tons. Conversion to diesel power was made by the Highway Equipment Co., Pittsburgh distributors of the Detroit Diesel Engine Div. of General Motors.

Power Units For 1960 Trucks

By 1960, heavy-duty automotive engines in general, will provide ½ bhp per cu in of piston displacement for gasoline and 0.4 bhp per cu in for diesels. This was expressed by Max Roensch, research engineer of Ethyl Corp., at a recent company-sponsored transportation conference.

He further indicated that the compression ratio will be 7.5 or higher with a 20 per cent improvement in

diesel economy. Diesel engines will also be available at 5 to 7 lb per hp. Operators are interested in an engine of the same or smaller size, he explained, and one that will exceed the power output of the present engine.

Oil Filtration Symposium

The considerable technological advances made during and since World War II in oil refining and engine design, stress the importance of factual knowledge on oil care. With this in mind, the Department of Engineering of the University of California, in cooperation with the American Society of Lubrication Engineers, is planning a 2-day symposium for discussion of the many facets of effective oil filtration in modern engines and hydraulic power mechanisms. It is to be held Feb. 11 and 12, 1954.

World's Largest Coupling

The Fast's Coupling Dept. of Koppers Co., Inc., has announced the completion of the world's largest industrial self-aligning coupling. Custom-built, it required six months to machine and assemble. The record all-metal coupling can transmit as much as 62,000 hp in straight-line and will be shipped to Italy where it will carry power to a Mesta 110-in, four-high reversing plate mill. Some idea of the size of the coupling is indicated by the fact that the motor hub had to be machined to fit a shaft 32.5-in in diameter.

New Marion Distributors

Marion Power Shovel Co. announces the appointment of two new distributors, Tulsa Equipment Co., Inc. of Tulsa, Oklahoma and Neff-Thomas Machinery Co. of Miami, Fla.

Petroleum Measurement Tables

In an action that will affect many contracts, the American Petroleum Institute recently announced that it is withdrawing its approval of the national standard petroleum oil tables issued in 1936. The Institute stated that the American Society for Testing Materials and the Institute of Petroleum has published a volume of recalculated and extended petroleum measurement tables, and that it is endorsing these as the new national standards. The tables will become effective January 1, 1954.

Cummins Expands

Steel erection for a building to house a new 300-ft, air-conditioned, high-speed assembly line is now in progress at Cummins Engine Co., Inc. The building will have three floors. This plant expansion, part of a $7 million program, is designed to increase production and plant efficiency. Plans call for completion of the structure by early winter.

Canadian Diesels For Pakistan

Pakistan's East Bengal Railway is awaiting delivery of six Canadian-built diesel-electric locomotives recently loaded aboard a freighter in Montreal. The 430-ton shipment came from the London, Ont. plant of General Motors Diesel Ltd. and is the first of Canadian origin to go into service on the 68-year-old railway.

The units weigh about 80 tons each, fully equipped, and are rated at 1125-hp. They have 6-wheel, 2-motor trucks.

New Plow Speeds Track Repairs

Canadian National Railways is speeding up its roadbed maintenance with a new machine that lifts the track,

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FACTORY NEW
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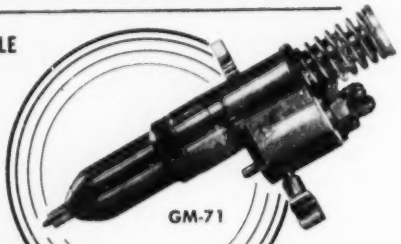

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Two sizes available — No. 53 with 4 to 23.3 gpm. capacity, and No. 55 with 9 to 34.1 gpm. capacity — at 0 lbs. pressure. Write for Pump Catalog listing complete line for diesel applications. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

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- 9999.9 hour range
- 10,000 hour automatic reset
- —55 to + 55°C. operating temperature.

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"WORLD'S MOST EXPERIENCED GOVERNOR MANUFACTURER"

scoops out old ballast, and levels the roadbed in a single operation. Designed and built by the company, the plow recently made its debut near Varennes, Que., where work is underway to replace gravel ballast with rock ballast to meet increasing traffic requirements.

The plow weighs four tons and measures 21 ft in length and 13 ft in width. It is inserted under the track and pulled along at four miles an hour by a locomotive. It elevates rail and ties a foot high while plow wings remove the old ballast and spread it over the shoulders of the roadbed to provide a wide base for the new ballast.

Atomic Energy in Oil Industry

The rise of atomic energy will not spell the decline of the oil industry, according to William M. Holaday, director of laboratories for Socony-Vacuum Oil Co., Inc. Atomic energy as fuel for electrical power plants will have a rough time competing with conventional fuels, he states. In an article in the company's publication, "The Flying Red Horse", Mr. Holaday says the oil industry is making good use of atomic byproducts to improve its own products.

Mr. Holaday discloses that his company is operating an atom smasher at its research laboratories near Dallas, Tex., which he believes is the only one in the oil industry. Radioactive materials have been used to trace the progress of oil through pipe lines, the path of catalysts in refining, and now, Mr. Holaday says, "tracers help us discover just how oil, gas, and water flow in the ground and at what rates of flow we get the most oil out." At the moment, researchers are working with the AEC on an atomic test for harmful metals in crude oil. They can detect one part of arsenic in a billion parts of crude oil.

Organizational News

Bristol Sales Manager

Ernest Nuber has been named sales manager, instrument division, of the Bristol Co., an organization he has been with since 1929. He advances from the position of manager, application engineering department.

Kuljian Sales Vice President

Herbert G. Johnson has been appointed to the position of vice president in charge of sales of The Kuljian Corp., with headquarters in Philadelphia. Mr. Johnson is also president of the Delta Oxygen Co., an affiliate of the corporation, and has had 20 years of experience as consultant on industrial processess, construction and operation.

H. G. Johnson

Honan-Crane Engineer

Honan-Crane announces the appointment of George B. Furey to its sales engineering staff. Mr. Furey has been with the company since March 1952. He will cover central and northwestern Indiana and will headquarter at the company's main office in Lebanon, Ind.

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Caterpillar Changes

Further decentralization of engineering functions due to its growth into a multi-plant operation, has been announced by the Caterpillar Tractor Co. G. E. Burks, who has become director of engineering, will have the responsibility of coordinating the program of all engineering groups serving the various plants and divisions of the company.

John E. Jass will succeed Mr. Burks as chief engineer of the Peoria plant. Paul B. Benner will become assistant chief engineer at the Peoria plant with supervision over design of motor graders and wheel tractors. Carl L. Kepner will become assistant chief engineer with supervision of earthmoving equipment now manufactured at the Joliet plant.

I-H Appoints Sales Personnel

The appointment of I. P. Payne as manager of industrial power sales has been announced by the International Harvester Co. Named as assistant managers of sales were C. E. Jones and W. M. Holland. L. J. Lange was designated general supervisor of sales development and E. A. Braker, general supervisor of sales engineering.

The announcement also named three regional and assistant regional sales managers to direct sales activities within 20 territories blanketing the country. Western regional sales manager will be H. E. Broadwell with Jack Bess as assistant sales manager. L. A. Coomer will head central regional sales with W. F. Hall serving as assistant manager. E. L. Boughton will be manager and J. D. Gladden assistant manager of eastern regional sales.

Pesco Promotion

The Pesco Products Div. of Borg-Warner Corp., announces the appointment of Paul W. Brannon to vice president of manufacturing. Mr. Brannon has been associated with the division since 1952 and more recently served in the capacity of manager of manufacturing.

Nordberg District Manager

The appointment of H. J. Feichtmann, sales engineer, as district manager of the heavy machinery division, north central territory, has been announced by Nordberg Mfg. Co. He will serve customers in northwest Wisconsin, Minnesota, the Dakotas, Wyoming, and eastern Montana, with headquarters at the home office in Milwaukee.

H. J. Feichtmann

Formerly with International Harvester, he joined Nordberg in 1948 as an engineer in the diesel engine erection and test floor department. He was appointed sales engineer in 1949 and after two years of active duty in the Navy, he returned to Nordberg in 1952 to resume his position as sales engineer.

Air-Maze Appoints Managers

The appointment of Frank P. Purvis to the newly created post of general sales manager and that of Harold E. Donovan as railway sales manager has been announced by the Air-Maze Corp.

Mr. Purvis has been Chicago district manager for the past seven years. Previous to that he had been connected with Cooper-Bessemer Corp. and Packard Motor Car Co. Mr. Donovan is an engineering graduate of Marquette University.

New Oakite Executives

Following a board of directors' meeting of Oakite Products, Inc., three changes in the management organization were announced. J. J. Basch, former Philadelphia division manager, was appointed manager of research and product development. E. H. Steif, general attorney of the company, was appointed assistant secretary and elected to the board of directors. W. A. Baltzell, former southern division manager, was named assistant sales manager.

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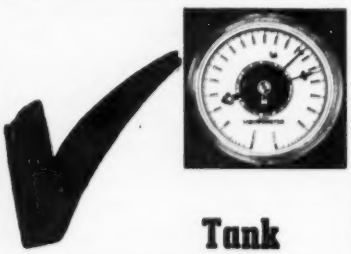

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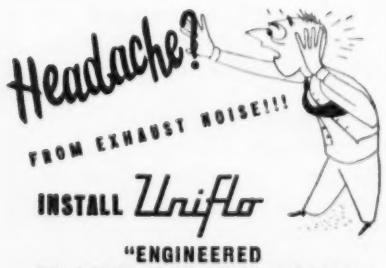

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Sharples Names Executive

The appointment of Fred W. Stakelbeck to the post of executive vice president has been announced by The Sharples Corp. Mr. Stakelbeck joined the company in 1934 and served in various company sales offices prior to being made works manager in 1943. In addition to his new duties, he will continue as vice president in charge of production.

F. W. Stakelbeck

New P&H General Manager

Harnischfeger Corp. announces the appointment of Frank C. Edwards as general manager of the P&H Diesel Engine Div. Mr. Edward's entire business career has been spent with the organization. He began his employment in 1925. For the past four years he has held the position of sales manager of P&H's Small Excavator Div.

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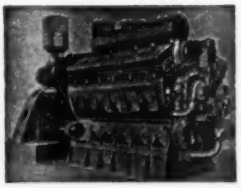

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Trane Laboratory Director

The appointment of Donald H. Krans as director of its new $1 million laboratory has been announced by The Trane Co. He comes to the company from the University of Illinois, where he was professor in charge of the school's heat power laboratory.

New Waukesha Director

Waukesha Motor Co. announces the election of Morgan R. Butler, Sr. as a director of the company. He is president and treasurer of the Butler Bin Co. in Waukesha and is a former mayor of the city, serving from 1926 to 1934.

Open New Trailmobile Branch

Increasing demand for commercial truck-trailers in the New England area has led to the establishment of a new factory branch of Trailmobile Inc. in New Haven, Conn., it was recently announced.

Kenneth A. Jeffries has been named manager of the new branch. He has been associated with the company, a subsidiary of Pullman Inc., since 1949. Previous to that, he was connected with the Philip Carey Mfg. Co. for 10 years.

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ADVERTISERS' INDEX

A & D Diesel Service, Inc. 104
Aerofin Corp. 84
Allison Division, General Motors Corp. 23
American Air Filter Co., Inc 8
American Bosch Corp. 29
American Brass Co. 14
American Locomotive Co. 30
American Motors Co. ***
Atlantic Metal Hose Co. 98

Bacharach Industrial Instrument Co., Inc. 27
Baldwin-Lima-Hamilton Corp. ***
Beard & Stone 105
Bendix Aviation Corp. Scintilla Magneto Div. 36
Borg-Warner Corp., Rockford Clutch Div. ***
Bowser, Inc. (Petroleum Marketing Div.) ***
Briggs Filtration Co., The ***
Brodie System 106
Brown & Sharpe Mfg. Co. 102
Brush ABOE, Inc., Petter Engine Div. 33
Burgess-Manning Co. 83
Burlington Instrument Co. 103

Carolina Rim & Wheel Co. 104
Carson, John F. 107
C. A. V., Ltd. 90
Chicago Metal Hose Division 91
Chicago Pneumatic Tool Corp. ***
Cities Service Oil Co. 9
Columbia Electric Mfg. Co. ***
Connell Co., W. J. 104
Coretti-Gross, Inc. 104
Cook Mfg. Co., C. Lee 2
Cooper-Bessemer Corp., The ***
Cummins Engine Co. 16-17
Cuno Engineering Corp ***

De Laval Separator Co. 32
Delco Products Div., General Motors Corp. ***
Delco-Remy Div., General Motors Corp. ***
Detroit Controls Corp. 92
Detroit Diesel Engine Division, Gen. Motors 7
Diesel Fuel Injection Service Co. 104
Diesel Injection & Governors Service 104
Diesel Injection Sales & Service 104 105
Diesel Plant Specialties Co. 107
Dexter Folder Co., Miehle-Dexter Supercharger Div. 101
Dollinger Corp. 15
Donaldson Co., Inc. 100

Eaton Manufacturing Co. 28
Electric Parts & Service Co. 104
Electric Storage Battery Co., The 20
Electro-Motive Div., Gen. Motors Corp. 34
Electro Products Laboratories 94
Elliott Co. Third Cover
Ellwood City Forge Co. 98
Enterprise Engine & Machinery Co. 21
Erie Forge & Steel Corp. ***

Fairbanks-Morse & Co. 25
Fairchild Engine & Airplane Corp. 35
Federal-Mogul Corp. ***
Fitzgerald Mfg. Co. 100
Flexonics Corp. 91
Florida Diesel Service Co. 104
Fram Corp. ***
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. ***

G & K Diesel Service 102
General Motors Corp., Allison Div. 23
General Motors Corp., Delco Products Div. ***
General Motors Corp., Delco-Remy Div. ***
General Motors Corp., Detroit Deisel Engine Div. 7
General Motors Corp., Electro-Motive Div. 34
General Motors, Harrison Radiator Div. 18
Gulf Refining Co. 38

Hancock Diesel Service 107
Harnischfeger Corp., P & H Diesel Div. 4
Harrison Radiator Div., Gen. Motors Corp. 18
Hilliard Corporation, The 92

Illinois Testing Laboratories, Inc. ***
Ingersoll-Rand Corp. 11
Interstate Diesel Service Inc. 107
Interstate Training Service 107

Johnson Bronze Co. 87

Kent-Moore Organizations, Inc. 95
Kiene Diesel Accessories, Inc. 101
Koppers Co., Inc., American Hammered Piston Rings Dept. ***

Lanova Corporation 88
Lence-Neville Co. ***
Link-Belt Co. 19
Liquidometer Corp., The 106

Madison-Kipp Corporation 6
Magneto Ignition Co., Inc. 104
Manzel ***
Marine Products & Engineering Co. 106
Maxim Silencer Co., The ***
Miehle-Dexter Supercharger Div., Dexter Folder Co. 101

National Welding & Grinding Co. 94
Nordberg Mfg. Co. ***
Nugent & Co., Wm. W. ***

Oakite Products, Inc. 93

Parks & Hull 104
Penn Controls, Inc. 97
Petter Engine Div., Brush ABOE, Inc. 33
Pierce Governor Co., The 103
Powers Regulator Co. ***
Precision Parts Corp. 104
Pure Oil Co., The 32A, 32B, 32C, 32D
Purolator Products, Inc. 10

Quincy Compressor Co. 89

Read Standard Corp. ***
Rockford Clutch Div., Borg-Warner Corp. ***
Roder-Blackburn International Corp. 107
Roper Corp., George D. 82

Schoonmaker, A. G., Inc. 106
Scintilla Magneto Div., Bendix Aviation Corp. 36
Sealed Power Corp. ***
Seattle Injector Co. 105
Sharples Corp., The ***
Sinclair Refining Co. 22
Snap-On Tools Corp. 86
Snow-Nabstedt Gear Corp. 95
Southern Maryland Electric Cooperative, Inc. 107
Standard Oil Co., Inc. (California) 26
Standard Oil Co., Inc. (Indiana) Fourth Cover
Sticht Co., Inc., Herman H. ***
Sullivan Brothers 104
Synchro-Start Products 31

Texas Company, The 2nd Cover & 1
Texas Power & Light Co. 107
Thomas Flexible Coupling Co. 93
Tide Water Associated Oil Co. 13
Tuthill Pump Co. 95

Utilities Engineering Institute 106

Van Der Horst Corp. ***
Van Norman Co. 5
Vellumoid Co. 107
Viking Pump Co. ***

Waukesha Motor Co. 79
Weston Electric Instrument Corp. 85
Wiegand Co., Edwin L. 99
Winslow Engineering Co. 12
Womack Brothers 104, 105
Worthington Corporation ***
Wyman-Gordon Co. ***

Young Radiator Co. 24

Bellefontaine, Ohio builds a new diesel plant-

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Bellefontaine, Ohio, has three new turbocharged Superior diesels, each with a turbocharged rating of 1423 bhp. The engines, of 360 rpm, each drive 1000-kw generators. They are dual-fuel engines, operating on gas during the summer, when the city's gas plant produces a surplus, and on normal diesel fuel at all other times. The periodical change of fuel makes no difference to the efficient operating of turbochargers. The new station is less than a year old, having started operation April 5, 1952 to help meet a growing load beyond the capacity of the steam plant already in service. In addition to Elliott turbochargers, several Elliott Crocker-Wheeler motors are used in the plant to drive engine auxiliaries.

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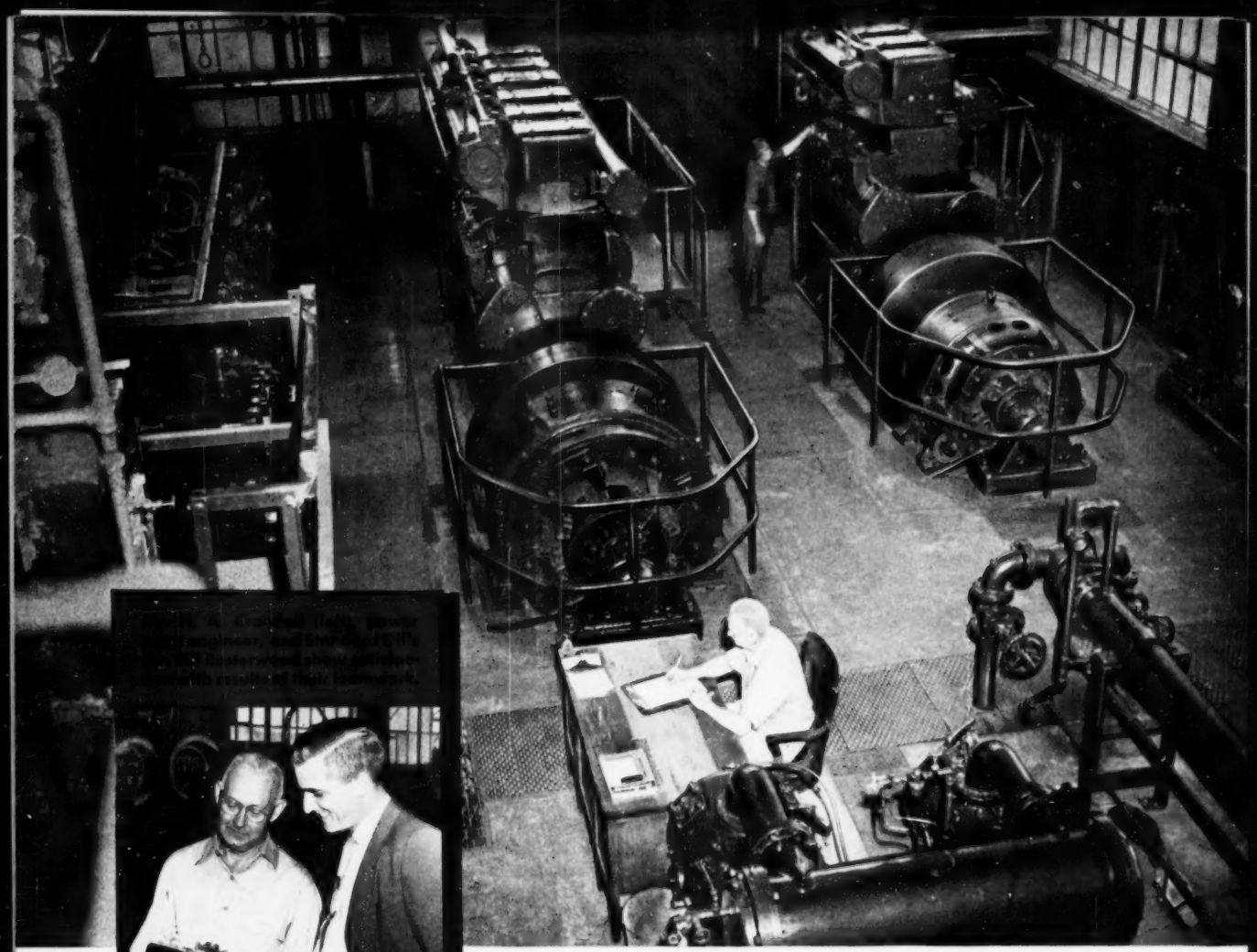

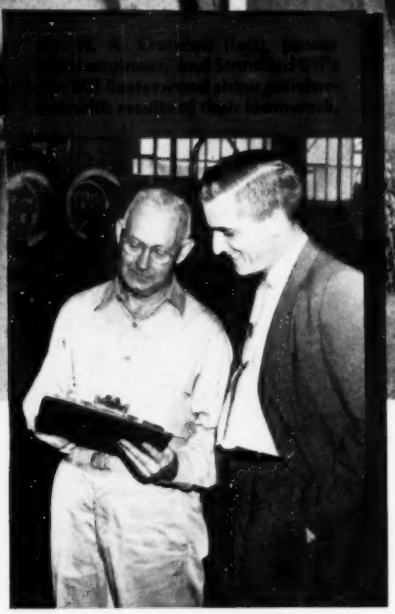

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